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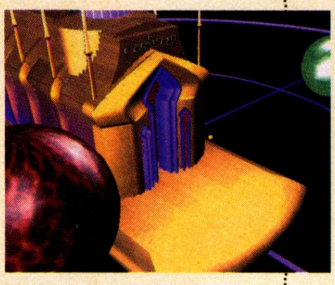
COMPUTER GRAPHICS WORLD
INNOVATION IN VISUAL COMPUTING
Volume 22, Number 10
October 1999

CONTENTS

28 All the Right Moves

Prince of Persia makes a dashing entrance into 3D gaming, while maintaining the hallmarks of the popular series—fluid movement and richly textured imagery.
• *By Karen Moltenbrey*



35 3D on the Web

E-commerce sites are beginning to use 3D graphics to differentiate themselves, keep shoppers on the site, and help sell products.
• *By Barbara Robertson*

40 Taking Stock

The New York Stock Exchange takes Wall Street into the new millennium with its 3D trading floor.
• *By Karen Moltenbrey*

47 Knowledge-Driven CAD

Though CAD vendors all have different names for it, software that captures and leverages a company's design know-how promises similar benefits for product manufacturers—simpler design, lower cost, and shorter time to market.
• *By Jeffrey Rowe*

54 Real Troopers

Animators use a plethora of techniques to bring a unique and highly stylized look to daily children's television with the debut of *Roughnecks: Starship Troopers Chronicles.*
• *By Karen Moltenbrey*

ON THE COVER
The eponymous hero of *Prince of Persia 3D*, the third installment in the enormously popular game series, was modeled in NewTek's Lightwave 3D and textured in Discreet's 3D Studio Max. Details such as the color of the prince's clothing and the design of his sword reflect the developers' in-depth research of 12-century Persian art and architecture. For more about *Prince of Persia 3D,* see page 28.

DEPARTMENTS

Editor's Note 6
Invisible Interfaces

Letters 10

Spotlight 12
News & Products

Tech Watch 19
A Surgical Simulation with Feeling
Animal Motion

Market Outlook 26
Growth Is the Only Constant

Portfolio 56
Cannes Digital Festival

User Focus 59
Dinosaur Attack Simulation
Conoco's Virtual Theme Park
A CAD Snapshot

Reviews 67
SolidWorks 99
3D Studio Max R3
Intergraph TDZ 2000 GL

Products 71

Events 74

Insight 80
Current Events

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Invisible Interfaces

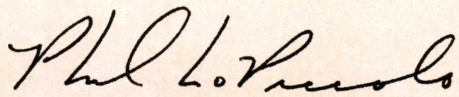
If there's one venue at the annual Siggraph conference that I look forward to visiting as much as any it has to be the Emerging Technologies pavilion. It's the one place where those of us fascinated by new computer graphics research get to witness the unveiling of the year's most promising projects. What's more, it's an opportunity to try out the systems, talk to the inventors, look for technology trends, and discuss their implications for the future.

At this year's Siggraph, held in August in Los Angeles, some two dozen Emerging Technologies exhibits spanned a spectrum of intriguing themes, from immersive displays and augmented reality to interactive characters and artificial creatures. (Stay tuned for coverage of these and other developments in upcoming issues.) But the most striking trend that emerged from this diverse mix of applications was that more than half of them relied on novel techniques for making the user interface more intuitive and, in some cases, totally invisible. Consider these examples:

- Surface Drawing, developed by Caltech's Steven Schkolne, lets you create digital 3D models simply by sweeping out surfaces in midair with your hand. A dataglove with sensors tracks hand movement. And the surfaces, which appear through stereoscopic goggles to float above a workbench, merge seamlessly to form intricate shapes.
- City of News, by MIT's Flavia Sparacino, allows you to navigate Web pages, displayed on a large screen before you, by making hand gestures and walking from place to place on a map projected onto the floor. The system builds a color model of your body and uses machine vision to track your movements without wires, sensors, or suits.
- The Luminous Room, by MIT's John Underkoffler, projects computational data onto surfaces and lets you interact with it. In one demonstration, dotted lines representing wind speed and direction are projected onto a tabletop so that when you place your hand or other objects on the surface, the computer-vision system will recognize the obstructions and alter the flow accordingly.
- Music Bottles, by MIT's Hiroshi Ishii, uses colored bottles to contain and control digital information, in this case the sounds of a violin, cello, and piano playing Edouard Lalo's *Piano Trio in C Minor*. A custom-designed electromagnetic tag that can be wirelessly identified is embedded in each bottle so when you remove a cork from a bottleneck, the corresponding instrument begins to play.

While these user-interface technologies are remarkable achievements in their own right, their implications for making computing power accessible to more people are perhaps even more profound. "We are entering an era of 'embedded computing' in which computers will shrink to where they will be incorporated in our houses, our appliances, even our clothes," explains Kathryn Saunders, creative director of the Royal Ontario Museum in Toronto and chair of this year's Emerging Technologies program. "Thus, many of these researchers are looking for ways of delivering digital information without the traditional computer interface."

The Emerging Technologies exhibits offer one of the clearer visions of where the future of computing is heading. And if innovations introduced at this year's show are any indication, we haven't seen anything yet.



Phil LoPiccolo: Editor-in-Chief

COMPUTER GRAPHICS WORLD
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Phil LoPiccolo: Editor-in-Chief
phill@pennwell.com

Jenny Donelan: Managing Editor
jennyd@pennwell.com

Diana Phillips Mahoney: Chief Technology Editor
dianam@pennwell.com

Barbara Robertson: West Coast Senior Editor
barbaraRR@aol.com

Karen Moltenbrey: Associate Editor
karenm@pennwell.com

Michelle Lendway: Senior Editorial Assistant
MLendway@pennwell.com

Contributing Editors:
Laureen Belleville, Audrey Doyle, Evan Marc Hirsch, Mark Hodges, Douglas King, Caren Potter, Terry Wohlers, Evan Yares

Suzanne Heiser: Art Director
suzanneh@pennwell.com

Dan Rodd: Senior Illustrator
danro@pennwell.com

Wendy Wood: Group Production Manager
wendyw@pennwell.com

Karen Borch: Ad Services Manager
karenb@pennwell.com

Kathleen Greaves: Reader Service Manager
greaves@pennwell.com

Christine Poulter: Circulation Manager
christinep@pennwell.com

Susan A. Hughes: Marketing Manager
shughes@pennwell.com

Bill Pryor: Computer & Electronics Group Publisher, Senior Vice President
billp@pennwell.com

Computer Graphics World
Executive and Editorial Offices:
98 Spit Brook Rd.
Nashua, NH 03062-5737
(603)891-0123; FAX:(603)891-0539

CGW Online: www.cgw.com

For customer service and subscription inquiries only:
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TEL: (847) 559-7500
FAX: (847) 291-4816
POSTMASTER: Send change of address form to *Computer Graphics World*, P.O. Box 3296, Northbrook, IL 60065

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Advanced Technology Division

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Vice President Administration

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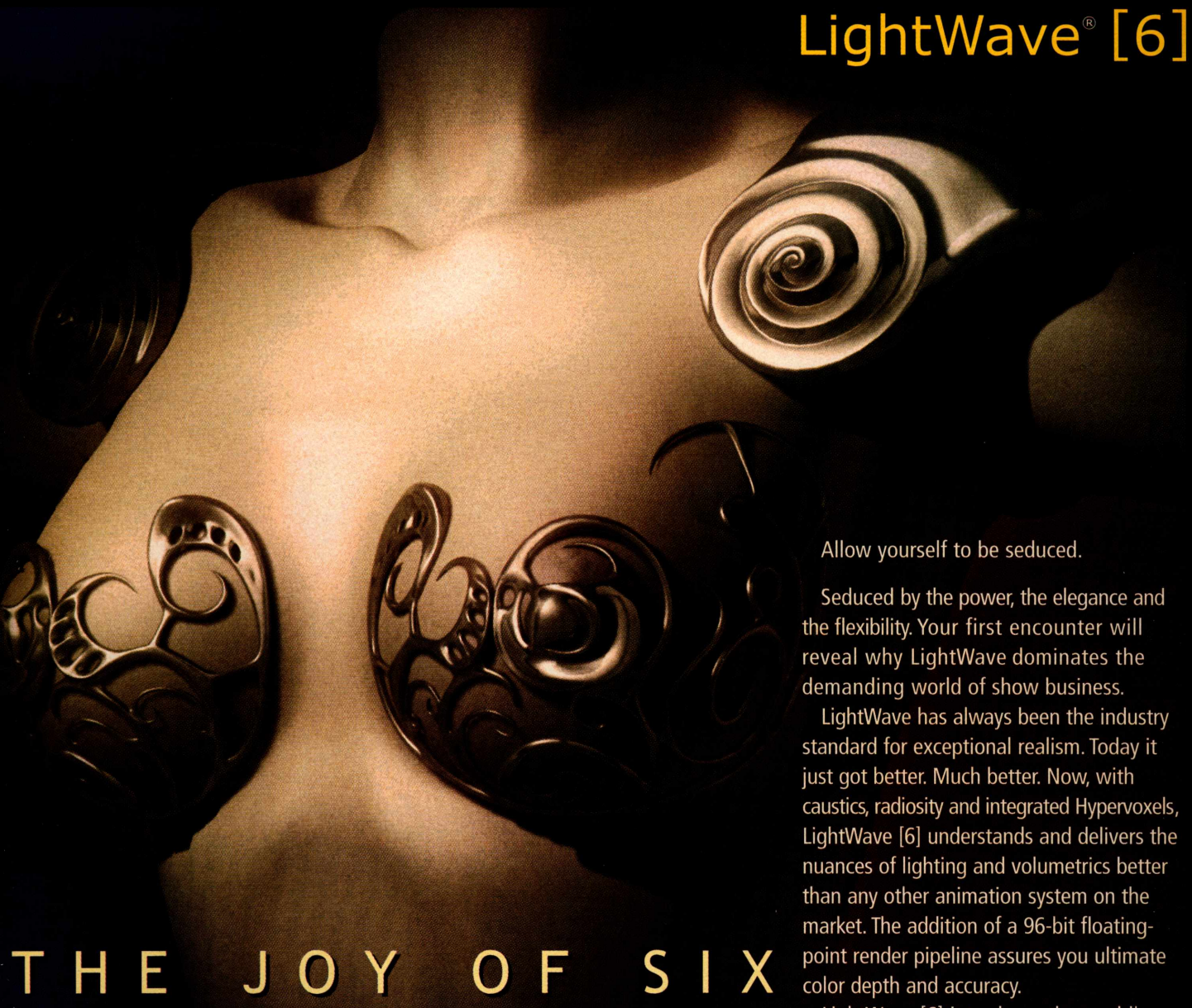

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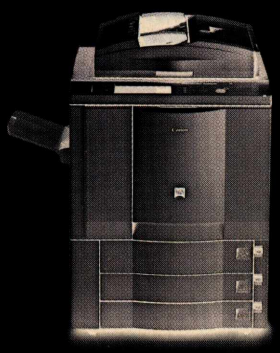

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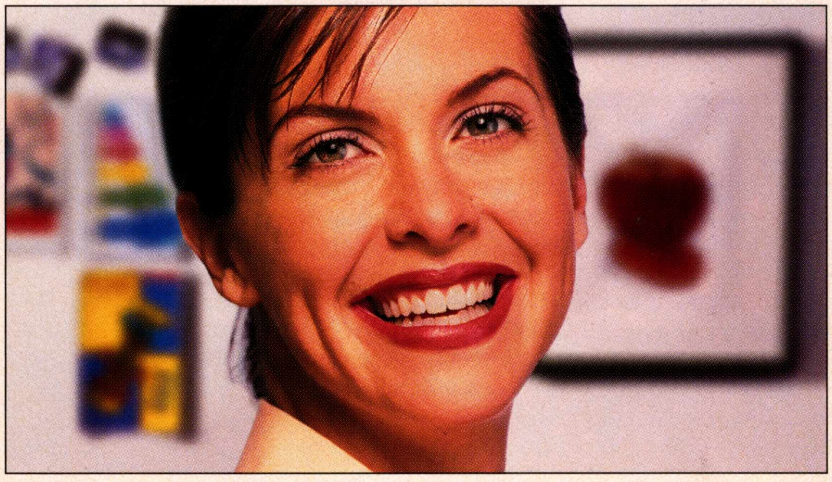

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Equal Time for PowerAnimator

"Powerful Procedures" in your August 1999 issue was a good article overall, but I did want to clarify some details about the creation of the blobby creature in the Square game *Parasite Eve.* The creature was not purely the result of a procedural system, and in fact, at least 50% of the shots were not even done in Side Effects' Houdini. I personally built and animated portions of the blobby creature shots using the forces, particle systems, and cluster-animated geometry that are part of Alias|Wavefront's PowerAnimator.

As a matter of pride, I'd like to point out that the PowerAnimator solution was adopted at Square after the Houdini approach had already been in an R&D stage for several months. A group of animators, including myself, was able to show that the program was more than capable of handling an equal number of shots. Furthermore, the technique was implemented with only two weeks or so of R&D.

I have nothing against Houdini— it's a cool application, and the animators produced some excellent work with it. However, PowerAnimator deserves equal recognition for those *Parasite Eve* blobby creature shots.

David Nix
Los Angeles, CA

Flat Panel Shortcomings

I wanted to share with you a few observations about the state of the flat-panel display industry. The current barriers to

growth in this area are well defined: Flat panels are expensive, hard to use in terms of achieving optimal image quality, and have not until recently approached the high-quality image display of which CRT monitors are capable. (See "Thin is In," May 1999, pg. 47).

Imagery on LCDs can be stunning, of course, but problems do arise in certain areas, such as broadcast applications, where up-scaling is required—NTSC, PAL, and SECAM video, for example.

Brad Zenger
Vice President, Marketing
Pixelworks
Tualatin, OR

Lost in the Shuffle

First, let me say that I love your magazine. I'm a LightWave user and have been reading *Computer Graphics World* for a dog's age. However, I've missed a few issues in recent months because most of the time I can't find the publication.

About a year ago, you changed the distinctive (and very well-designed) *CGW* logo at the top of the magazine to a more generic look, so that now your magazine blends in with the other 37 titles at the bookstore. I look and look, but of course I'm always in such a hurry that I give up and buy a copy of *Wired*, because frankly, I can always find *that* magazine.

Trust me, by joining the ranks of knock-off computer and Internet 'zines, your publication has for all intents and purposes vanished from the shelves. But again, *Computer Graphics World* is an awesome magazine—one of the few that deals with professional 3D issues.

Ian (last name withheld)
Edmonton, Alberta, Canada

Amiga an Important Milestone

Your August 1999 issue contained, as usual, a great deal of interesting information. However, I would like to add the Amiga 1000 (1985) to the roster of important milestones in your time line, "The Story of Computer Graphics" (pg. 64).

I have used Amiga computers since 1987. As an active member and former president of the Seacoast Area Amiga Users Group (SAAUG) in New England, I wanted to make sure that your readers know the Amiga was the first commercial multimedia computer to handle computer graphics and animation. And it did so years before color displays became standard equipment on the PC and Macintosh platforms.

Likewise, the Amiga Video Toaster application could have been included in the time line as the first broadcast-quality video production tool for a personal computer. The Video Toaster included a suite of powerful computer graphics tools, including LightWave, which has gone on to become one of the most popular 3D programs in use today.

Excluding the Amiga in the overall history of computer graphics just wasn't truthful.

Randy Payment
Heidelberg Web Systems
MIS
Dover, NH

Corrections

The SuperPaint artwork that appeared on page 65 of the computer graphics time line in the August 1999 issue was created by artist David Em on January 6, 1975, at Xerox PARC.

The image that accompanied the "Powerful Procedures" description in the August 1999 Table of Contents (pg. 3) was created by Ted Bedwell of the University of Maryland at Baltimore County. It is an example of genetically mated implicit surfaces.

We Value Your Input

We welcome any insights you may have that would further our readers' understanding of topics discussed in this issue. We may edit your response to conform to our style and space requirements.
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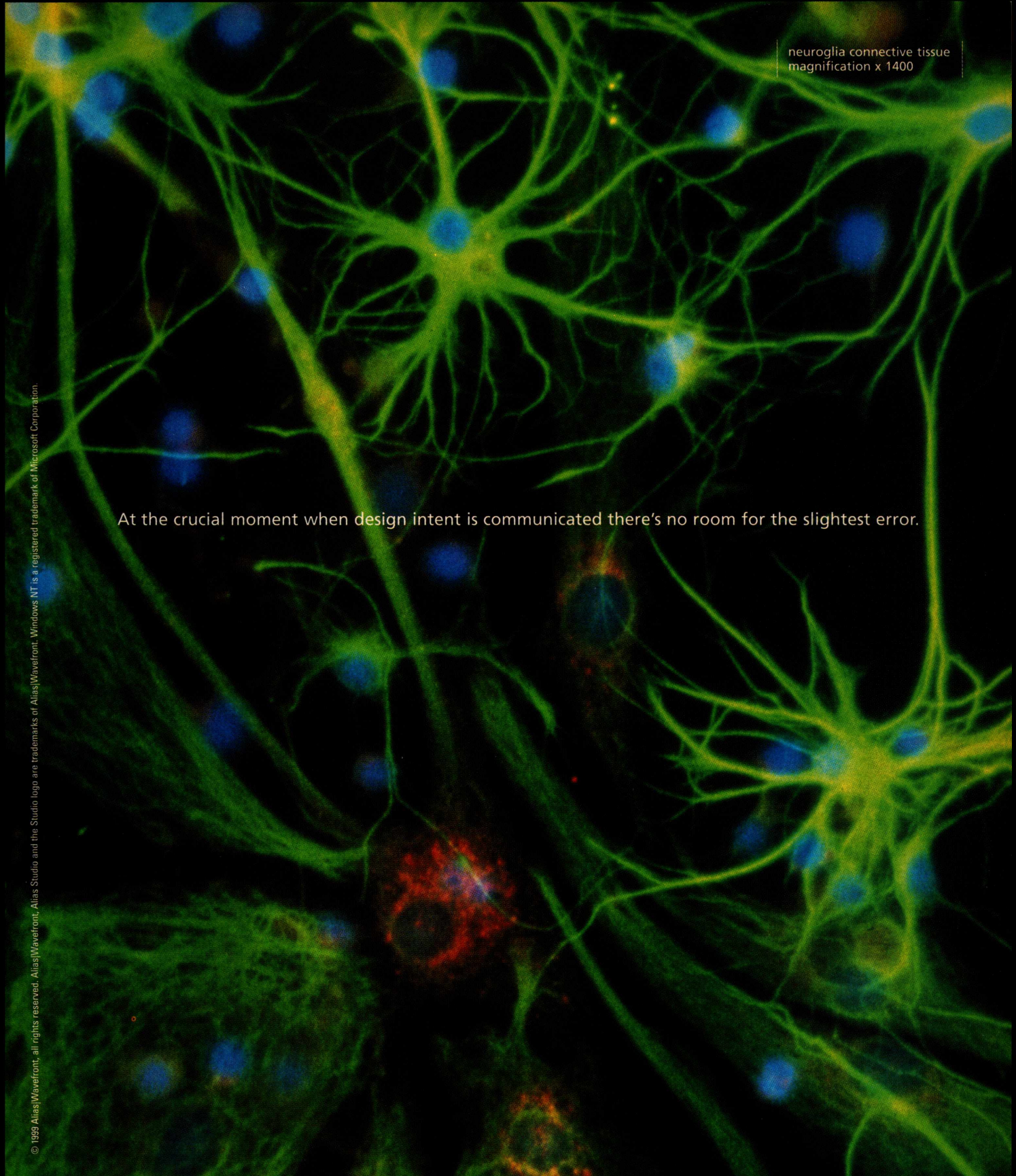

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SPOTLIGHT

NewTek Delivers LightWave 6

Boasting a new, user-customizable interface, a more efficient workflow, and significant upgrades to its rendering, animation, and modeling tools, the long-awaited overhaul of LightWave 3D debuted at Siggraph in August, and is scheduled to begin shipping this month. NewTek claims LightWave 6 encompasses the most significant upgrades to the popular 3D animation program in 10 years, and others agree. "It's definitely a major upgrade," says Wanda Meloni, senior analyst at Jon Peddie Associates (Tiburon, CA). "They've added important rendering capabilities and taken a look at the workflow process, which hadn't been addressed before. In addition, they've really worked on addressing issues for game development. It think it will be quite competitive."

The new interface features non-modal and floatable windows, contextual pop-ups, a floating tool bar, and numerous real-time views. An enhanced SDK (software development toolkit) gives third-party developers access to the interface and to internal functions, and, NewTek believes, makes the upgrade easier to integrate into production pipelines than its predecessor.

Among the rendering enhancements are the addition of radiosity, caustics, and 96-bit floating-point rendering with sub-pixel displacement for creating volumetric surfaces such as clouds. In addition, the program's HyperVoxel technology for raytracing of volumetric surfaces has been optimized. For modeling, 6 offers subdivision surface modeling with point weights, the control of UV mapping with infinite layering, animatable surface attribute, and gradient ramps that can use parameters such as bump height or incidence angle to change surface attributes.

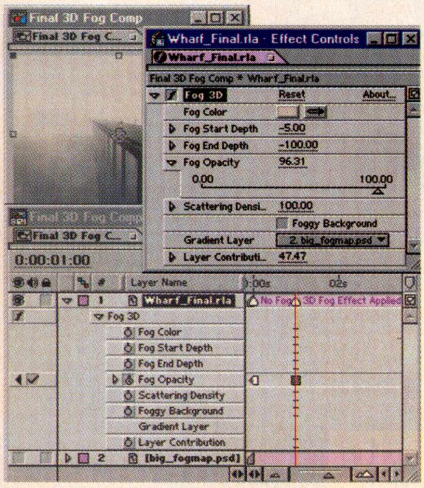
For animation, NewTek has added tools it calls IntelligEntities: skelegons, endomorphs, and multi-meshes. As changes are made to an object such as a character, for example, the bone structure (the skelegons) is automatically updated. Endomorphs give animators controls for facial expressions and lip sync; multi-meshes embed layers of geometry into a single object with all the defined relationship and pivot data for a hierarchical object saved as a single model.

Slated to begin shipping in September, LightWave 6 for Macintosh, Windows NT, Alpha, and SGI machines, is priced at $2495, with an upgrade price of $495. (NewTek; San Antonio, TX; 800-862-7837; www.newtek.com) —*Barbara Robertson*

infoNOW 106

Adobe Soups Up After Effects

Under the guise of a simple .1 release, Adobe Systems has added powerful new features to After Effects, its popular visual effects and motion graphics package. Highlights of version 4.1 include the ability to save favorite effects, support for more 3D file formats and higher image resolutions, a flowchart view of the hierarchy of footage and effects in compositions, a Collect feature that lets users gather all files into one location for rendering or archiving, and a keyframe assistant for automatically sequencing layers.



A particular boon to productivity is After Effects' unlimited render engine license (available only with the Production Bundle, the high-end, fully featured version of the product). Users may install the render engine on as many systems as they wish, then use the machines to render in the background while they continue to create more image sequences on their workstation.

"The render engine has come in very handy," says Sherry Hitch of special effects house Foundation Imaging in Valencia, California, which produces sequences for the *Star Trek: Voyager* television series. "And you are able to monitor the process of the engines as they render."

Both the render license and the ability to save favorite effects have improved productivity dramatically at Foundation Imaging, says Hitch. The new version, she claims, "speeds up the production process 10-fold. They really should have called it Version 4.5."

After Effects 4.1 operates on either a Power Macintosh running Mac OS 8.1 or later, or a Pentium III machine running Windows 98 or NT. The Production Bundle costs $1499 and the Standard Version costs $699, with other prices applying to various upgrades. (Adobe Systems; San Jose, CA; 800-833-6687; www.adobe.com) —*Jenny Donelan*

infoNOW 107

Alias|Wavefront Paints New Effects

Although Maya 2.5 from Alias|Wavefront boasts several powerful new features, the most impressive of these is the program's Paint Effects technology, which allows users to create—nearly instantaneously—organic shapes and movements in 3D space. Brushes offer a range of effects including complete environments with trees, grass, and flowers, characters with hair, eyebrows, and beards, and special effects such as lightning, clouds, rain, fire, fireworks, and sparks—not to mention pasta and meat. Paint Effects also incorporates traditional brushes, including airbrushes, oil paint, chalk, pastels, pencils, watercolors, wet brushes, and markers.

All Paint Effects brushes can be used either in 3D space, allowing users to paint on or between 3D objects in a scene, or on a 2D canvas, which is useful for creating both images and textures. The brushes can also be blended together to make an infinite number of new presets, and users can create and save their own customized presets.

"Paint Effects is certainly unique in the industry," says Wanda Meloni, senior analyst with Jon Peddie Associates. From a practical standpoint, "It can be used to fill in a background for a scene very quickly," she says. "This technology will certainly save some time and money."

Other highlights of Maya 2.5 include new polygonal modeling tools, multithreaded interactive photorealistic rendering, and increased Pentium III support. In addition, Alias|Wavefront has introduced yet another iteration of the product, Maya Builder, a subset of Maya Complete that has been optimized for game developers. The price for Maya Complete 2.5 is $7500. Maya Unlimited costs $16,000, and Maya Builder, $2995. (Alias|Wavefront; Toronto; 800-447-2542; www.aliaswavefront.com)—*JD*

infoNOW 108

Software Vendors Make the Leap to Linux

The Linux operating system, a variety of Unix that originated as Finnish freeware several years ago, has enjoyed a burgeoning grassroots support ever since. Now that support has spread to the ranks of digital content creators, and, as a result, some vendors have agreed to meet the growing demand for Linux-ready software.

At Siggraph in August, Alias|Wavefront (Toronto) announced that it will create Linux versions of its Maya Batch Renderer and Maya Composer Renderer to ship in Q4 of 1999. And earlier this year, Side Effects Software announced that it will port its popular Houdini 3D animation software to the Linux OS.

Among hardware vendors, the Linux trend is growing but not exactly new—Dell, for example, has sold a machine with Red Hat (a variety of Linux) for several years.

SGI Appoints New CEO

SGI (Mountain View, CA) has a new chairman and CEO in Robert Bishop, an SGI board member and former global sales executive. He succeeds Richard Belluzzo, who resigned to become Microsoft's group vice president for Consumer and Commerce.

Bishop's appointment follows a flurry of repositioning announcements from SGI, which include a separate business unit for the company's Cray vector supercomputers; the incorporation of graphics board maker Nvidia's accelerators in SGI's desktop graphics systems; a new strategy to offer out-of-the-box as well as custom virtual reality systems; a new focus on broadband Internet systems; and a separate business unit for its VisualWorkstation line of Windows NT-based workstations, which were introduced last winter.

Seventh Annual Digital Salon

The School of Visual Arts (New York) will host the Seventh New York Digital Salon (NYDS-7), an international traveling showcase of computer-generated artwork, at its Visual Arts Museum from November 8 to December 15. The exhibit will feature digital fine art, interactive installations and animated films, Web sites, and CD-ROMS. For more information, see http://www.sva.edu/salon.

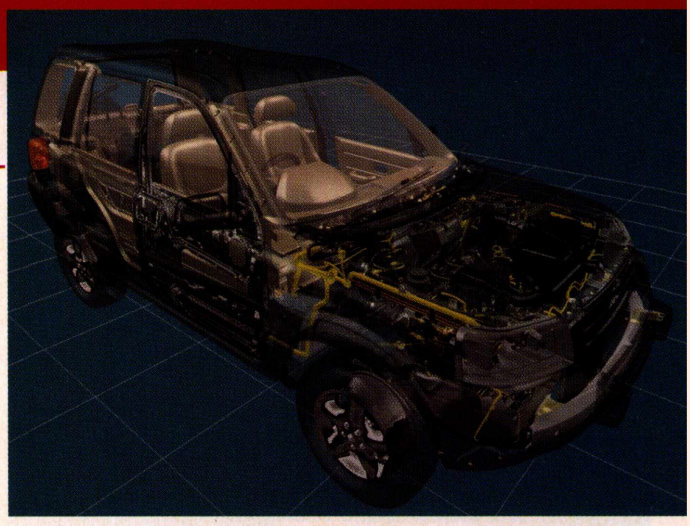
In Brief

Factory automation supplier **Adept Technology** (San Jose, CA) has signed an agreement to acquire **BYE/OASIS Engineering** (San Jose), a manufacturer of minienvironment systems.... **Iwerks Entertainment** (Burbank, CA) has signed a long-term agreement with international video game producer **Infogrames** to develop and distribute ride simulation, theme park attractions, and large-format films.... **SDRC** (Cincinnati, OH) will acquire **TD Technologies** (Richardson, TX), a systems design software development and services firm whose flagship product, SLATE (System Level Automation Tool for Engineers), will form the basis of new SDRC PDM extensions.... Immersive display supplier **Fakespace Systems** (Mountain View, CA) has merged with Pyramid Systems (North Kitchener, Ontario), maker of the CAVE and other immersive systems.

—Jenny Donelan, Managing Editor

SPOTLIGHT

PTC's New Division



One of the newest options in the highly competitive digital mockup arena is also one of the oldest. Division 2000i, a suite of engineering visualization tools from CAD vendor Parametric Technology Corp. (PTC), is the first product introduced under the Division name since PTC acquired the UK company last year. However, the "new" product line is backed by Division's venerable history as a pioneer in the area of virtual reality and engineering visualization. Division 2000i comprises four interoperable packages, each designed to address the various visualization needs of the entire engineering enterprise.

The first component, Division ProductView, is a Web-centric interactive visualization tool that provides 2D and 3D viewing and redlining capabilities to both casual and technical users. Division MockUp is targeted more directly at designers. With it, they can integrate multiple-source CAD models into a single, fully functional digital prototype long before a physical version is cast. The VR component, Division Reality, supports group design review in large-scale immersive display environments, such as the CAVE (Pyramid Systems) and the Immersive WorkWall (Fakespace). It utilizes a distributed architecture that leverages the high-end visualization capabilities of multi-processor, multi-graphics pipe computing configurations. Finally, Division EchoCast is a standalone 3D player for distributing compact functional virtual mockups across the Internet.

The Division 2000i product series is interoperable with PTC's i-Series CAD tools (Pro-Engineer and CADDS5), and can also integrate CAD data from other vendors' systems, including Catia and Unigraphics.

Additionally, the product line works with Windchill, PTC's product data management tool. "This is a powerful strategic component," says CAD industry analyst Bruce Jenkins of Daratech. "It enables direct access to product life cycle information from the visualization environment." Although it is a new product release, Division 2000i is in no way a "1.0 version," says Jenkins. "The Division technology has a deep heritage with some very significant technical underpinnings. Unfortunately, in the past, the prowess of the technology was always much greater than the marketing efforts supporting it. In the hands of PTC, there's no doubt it will get the exposure needed to solidify its position as an extremely credible and competent digital mockup tool." (Parametric Technology Corp.; Waltham, MA; 781-398-5000; www.ptc.com)

—Diana Phillips Mahoney

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InterSense Introduces Wide-Range Tracking

IS-900, the new motion-tracking product family from InterSense, is built on the company's proprietary Constellation technology and SensorFusion software. Using both inertial and ultrasonic tracking, the IS-900 architecture delivers tracking resolution of approximately one millimeter for position and less than one degree for orientation. According to InterSense, the combined technologies all but eliminate the jitter and lag common to motion-tracking systems, thereby greatly reducing the queasiness some individuals experience when using them.

One of the new product line's major strengths is its scope and expandability. A virtually unlimited tracking range can be created through the use of sensor strips installed in a ceiling. Movements of the head and hand gear worn by the user in the immersive application are tracked by the strips, so that the user can theoretically go anywhere the strips have been placed.

The IS-900 product line consists of the VET, a 3D volume tracker for immersive displays such as CAVEs and Cubes that offers six degrees of freedom for both head and handheld wand; the VWT, a virtual workbench tracker with six degrees of freedom for head and stylus; the LAT, a large-area tracker with flexible configurations for room and wall displays; and the SCT, a studio camera tracker that provides multi-camera tracking for production studios.

Prices for the various components, scheduled for fall 1999 shipment, vary from $18,000 to $30,000, depending on configuration. (InterSense; Burlington, MA; 781-270-0090; www.isense.com) *—JD*

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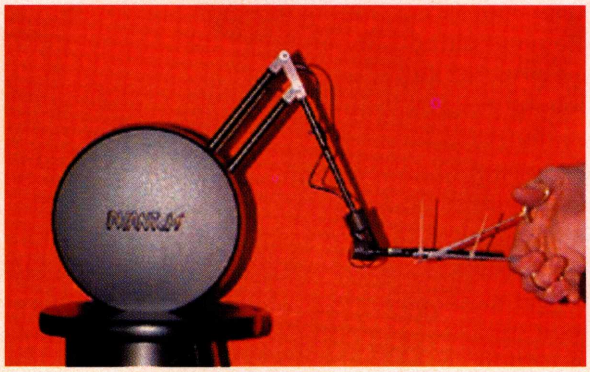
Getting the Feel of Virtual Surgery

A "smart" haptic simulator will help novice surgeons learn from the pros

DIANA PHILLIPS MAHONEY



Computer-based surgical simulation has for years been one of the hottest topics in virtual-reality research. Not only does the technology have the potential to revolutionize the teaching and practice of medicine, but it also encompasses some of the most pressing computer visualization challenges of the day: real-time interaction with complex 3D datasets, photorealistic visualization, and haptic (force-feedback) modeling. What's more, it requires that all of these be achieved in the same application.

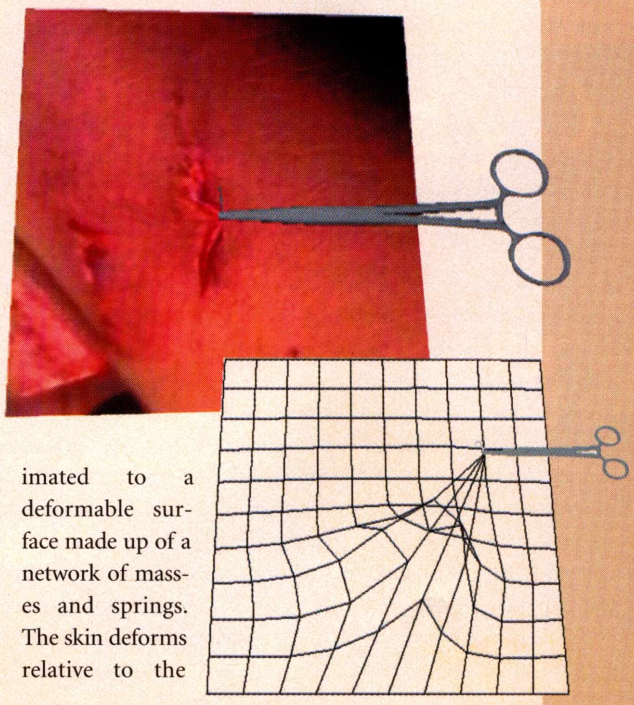
Few other VR applications are subject to such stringent constraints. Often, in other applications, one or more of the technical considerations mentioned above can be sacrificed for the sake of another. For example, if real-time interaction is a priority, it may be achieved at the expense of photorealistic images or sensitive force feedback and vice versa. In contrast, for a surgical simulation to be useful as a training and planning tool, it must answer to a higher technical call.

Roger Webster and Randy Haluck know this, and are building their surgical simulation system accordingly. Webster, a computer scientist at Millersville University of Pennsylvania, and Haluck, director of minimally invasive surgery at Penn State's Hershey Medical Center, have joined forces to develop a surgical simulator that will not only enable real-time interaction with photorealistic 3D imagery and sensitive touch feedback, but will also measure the skills of expert surgeons relative to novice surgeons, providing the novice with an objective means of identifying areas of strength and weakness.

The simulator will also be used to compare skills measured during live surgery with those obtained from a virtual procedure to test whether there is indeed a technology transfer between the two. "The general assumption is that virtual surgery simulation is beneficial. It seems intuitive, but it has yet to be proven, so we're setting out to do that," says Webster.

With funding from the medical center, the researchers have begun developing a computer-based simulation system representing a range of surgical procedures. An initial component is a proof-of-concept application that lets surgeons and medical students, via real-time visual and haptic interaction with a photorealistic model, practice suturing. The virtual environment for this application comprises polygonal models of patient anatomy. The skin covering the models is a grid of dynamic vertices texture-mapped with a photograph of an actual wound. To interact with the digital model, users manipulate physical suturing tools that are attached to a haptic device (the Phantom from SensAble Technologies), while viewing virtual counterparts of the same tools on-screen. The virtual environment was programmed using EAI/Sense8's WorldToolKit.

To model the sensations related to the "touch and feel" of the virtual objects in the environment, the researchers used SensAble's GHOST software development kit. To simulate the impact on the skin and underlying tissue of pushing, pulling, cutting, and so forth, they developed a basic mass-spring model, through which the skin is approximated to a deformable surface made up of a network of masses and springs. The skin deforms relative to the



A photograph of a wound is mapped onto a grid of dynamic vertices (below). The virtual skin responds to the user's interaction with suturing tools attached to the haptic device (above). Digital versions of the surgical instruments appear in the virtual environment.

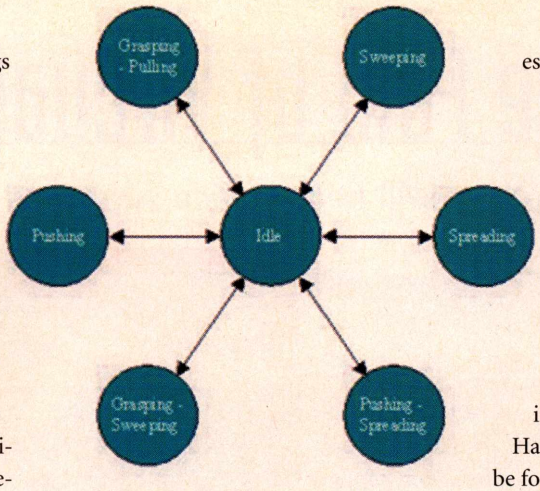
weight, or pressure, applied to the springs through the surgical tool. The software calculates the contact forces in the soft tissue surrounding the wound and applies the appropriate forces to the user through the Phantom. The resistant forces change when the needle is inserted into the virtual skin and when it's pushed through the soft tissue. The software graphically shows the deformation of the virtual skin as well.

The skills-assessment capability is also based on a mathematical model. To quantify surgical activity, the researchers are creating a software implementation of the finite-state machine model. With this, a range of surgical states and transitions between states will be tracked. The states include idle, grasping, spreading, pushing, sweeping, and lateral retraction, as well as numerous combinations of these, such as grasping/pulling, pushing/sweeping/spreading, and so forth. In the virtual environment, these states will be tracked directly from the motions of the Phantom. In physical surgery, the surgeons' motion will be tracked by an electromagnetic position and orientation sensor system and the data will be input to the software for motion analysis.

"The initial state is the idle state, where nothing is happening. When the user starts the procedure, he or she transitions to other states, like grasping, spreading, or pushing," says Webster. "All of these, and combinations of these, will be modeled as the user progresses from one state to another."

The goal, says Haluck, is to be able to quantify the nature of the states through which an expert surgeon progresses in performing a suturing operation. "We want to know how long the expert surgeon spends in each of those states so we can compare that against novice surgeons to see whether they go through the same states and transitions or different ones, and how long they spend at each state." For example, novice surgeons might spend an inordinate amount of time in the idle state, thinking about what to do next, or they may be pushing and grasping when, based on the expert's approach, they'd be better off pulling at that point in the suturing process.

Such information can be an invaluable training tool, says Haluck. "We can show the novice surgeon the different states and how long the expert spent in each of the them. And based on the numbers, we can say something like, 'You're spending too much time in the grasping and pulling state after you have been in the lateral retraction state.' The benefit is that it will give concrete skills-assessment feedback, rather than someone saying, 'I don't like the way you're suturing.' "



A software implementation of the finite-state machine model will provide the skills-assessment capability of the surgical simulator. A number of different surgical states, shown above, will be tracked and measured directly from the user's interaction with the haptic device.

Fine-tuning the Model

The project is still in the investigative stage, notes Webster, adding that there are a number of daunting technical and conceptual hurdles yet to overcome before the simulator is deemed surgeon-ready.

The first and most significant of these is fine-tuning the haptic model for soft-tissue deformation. "This is one of the more difficult problems in virtual surgery. There are a number of classic computer graphics things we can do to make the simulation *look* more realistic, but in terms of making it *feel* more realistic, we're just starting to scratch the surface," says Webster. "In our research, we're trying to invent an engineering model of how tissues and organs should feel. We need to tweak the model to get more accurate resistant force calculation algorithms."

Haptic accuracy is mission-critical, says Haluck. "Everything we do as surgeons relies on force feedback. Organs and blood vessels respond to manipulation and tissue handling. And the forces involved are essential to identifying pathology, determining tumor boundaries, and assessing how the repair is going. We have to have the same sensory involvement in a simulation."

Some of the other obstacles the researchers face relate to the field of computer-based surgical simulations in general. "The whole notion of computer-based surgical training outside of the actual operating room is underappreciated," says Haluck. "For example, the NIH seems to be focused on molecular-level research, but when it comes to education and training, funds are limited." Additionally, he says, there is a resistance to change within the surgical community. "There's a necessary time commitment to training outside the operating room. The thought of fitting in extra hours for simulation training has little appeal to a surgical resident who is already pulling 36-hour shifts. A surgeon beyond residency training in a busy practice may react similarly."

Not making the time, however, is an increasingly dangerous pattern, particularly in these days of rapid-fire high-tech advances that are meant to help save lives. "Every day, new technology is being tossed at us. In the good old days, you could train by learning to cut, sew, and tie, and those skills would get you through an entire career. Today, especially as computer power increases, we're faced with new technology all the time—different visualization techniques, and different skills requirements, such as laparoscopic surgery and robotic surgery," says Haluck. "The technology is coming so fast that the opportunities for complete training are limited. Obviously, research into better teaching methods and better skills assessment methods will make the transition safer. A critical component of that is computer-based simulation."

Eventually, the haptic simulation system will serve as a teaching tool for Penn State's College of Medicine and other medical schools. Information about the system is available on the project Web site at http://cs.millersv.edu/haptics/index.html.

Diana Phillips Mahoney is chief technology editor of Computer Graphics World.

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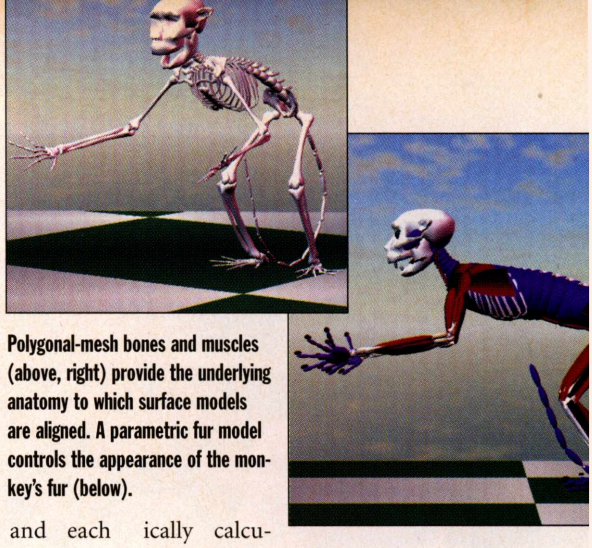
Something in the Way They Move

An interactive technique for matching surface models to underlying anatomy helps researchers realistically animate animal movement

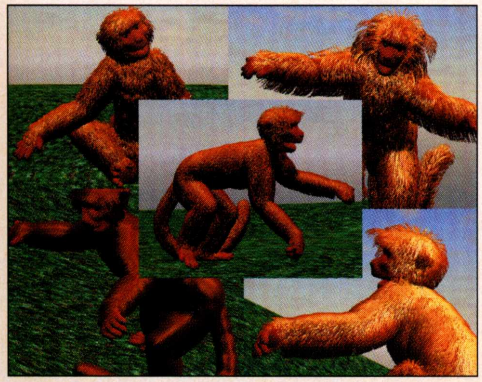


Polygonal-mesh bones and muscles (above, right) provide the underlying anatomy to which surface models are aligned. A parametric fur model controls the appearance of the monkey's fur (below).

As evidenced in such movies as *Jurassic Park* and *Star Wars Episode One: The Phantom Menace*, animators have made tremendous strides in their efforts to create digital creatures that move in a physically believable manner. What's not obvious to the uninitiated, however, is the cost—in blood, sweat, tears, time, and money—that each such stride represents. Despite recent advances in 3D modeling and animation, there are still no easy, automated tools for re-creating human and animal motion. Typically, doing so requires a "brute force" approach using one or a combination of many available techniques.

In an effort to automate the process, researchers at the University of California, Santa Cruz (UCSC) have developed a system that matches surface models of living creatures to their underlying muscles and bones, representing both the shape transformation of the muscles during joint motion and the associated skin deformations. The system, called Zoo, addresses some of the pitfalls of more traditional animal modeling and animation methods.

"Animal motion is so complex that it's an abysmally difficult problem trying to figure out what each joint is doing at every time step," says UCSC computer science professor Jane Wilhelms, who developed the anatomy-matching process with graduate students Jeffrey LaPierre and Philip Schneider (http://www.cse.ucsc.edu). "It's certainly possible to get motion that looks good using motion capture. But if you want to make small variations—if you want the animal to run up hill instead of on flat ground, for example—you've got to recalculate all the joint angles. And there's the whole issue of coordination. There are many different ways of moving, and each [involves] different joint behavior."



The skin presents numerous obstacles as well, says Wilhelms. "You have to figure out how to make it move so that it realistically imitates what's going on with the muscles, and how to make it move over the joints so it doesn't look stretched out of shape."

The technique Wilhelms' group has developed involves placing an articulated animal anatomy inside a polygonal skin and anchoring the skin to the anatomy. The skin is an elastic model, and thus moves and responds to the changes of the underlying anatomy and neighboring skin vertices.

Building the Framework

At the heart of this process is a hierarchical structure of components such as bones, muscles, and generalized tissue that have been modeled polygonally. To align the underlying anatomy to a surface model, the system uses "super segments," which are sets of connected sections between two successive joints in a single chain. Instead of having to make single joint adjustments to define specific movements, users can manipulate each super segment as a unit (using rotation, translation, scaling, and inverse kinematics capabilities), and the associated geometry changes accordingly.

A range of interactive capabilities allows the user to retain low-level control over the model. For example, "nodes" can be placed anywhere along a super segment to break it into smaller super segments, and existing super segments can be coalesced into larger ones. To achieve finer control over a joint change, the user can apply an arbitrary weighting function to modify the transformation. For example, to make one end of a segment rotate more than the other, the user can weight the manipulation accordingly.

The inverse kinematics function automatically calculates joint positions based on a goal position in the world, and can be weighted by the importance of individual joints. To prevent a universal adjustment when a given super segment manipulation is made, the user can place constraints on individual joints. For example, if the user is satisfied with the placement of the hand, but wants to adjust the elbow, the joints of the hand can be constrained. The system remembers the locations of the constrained joints and restores them to their position when they're displaced.

After the locations and orientations of joints and segments are established, the model is "skinned" by attaching skin surface vertices to the nearest underlying component. When the joints move, the skin adjusts automatically relative to neighboring skin points and anatomy connections.

The anatomical models are general enough so the underlying components can be swapped between animals. "If you create a cat model with the right kind of muscles, you can pretty much go to other cat [surface] models and get similar skin deformations that look realistic, and you can map it onto other four-legged animals with interactive help from the user," says Wilhelms.

Wilhelms is quick to stress that this system is still a work-in-progress. The researchers are exploring a number of avenues for acquiring realistic motion and matching it to the anatomical models. One involves linking the models to video by utilizing computer-vision techniques for edge detection and surface tracking across video frames. Another is the use of biomechanical data such as CT and MRI scans to create more detailed anatomical models and, consequently, more realistic motion.

Diana Phillips Mahoney is chief technology editor of Computer Graphics World.

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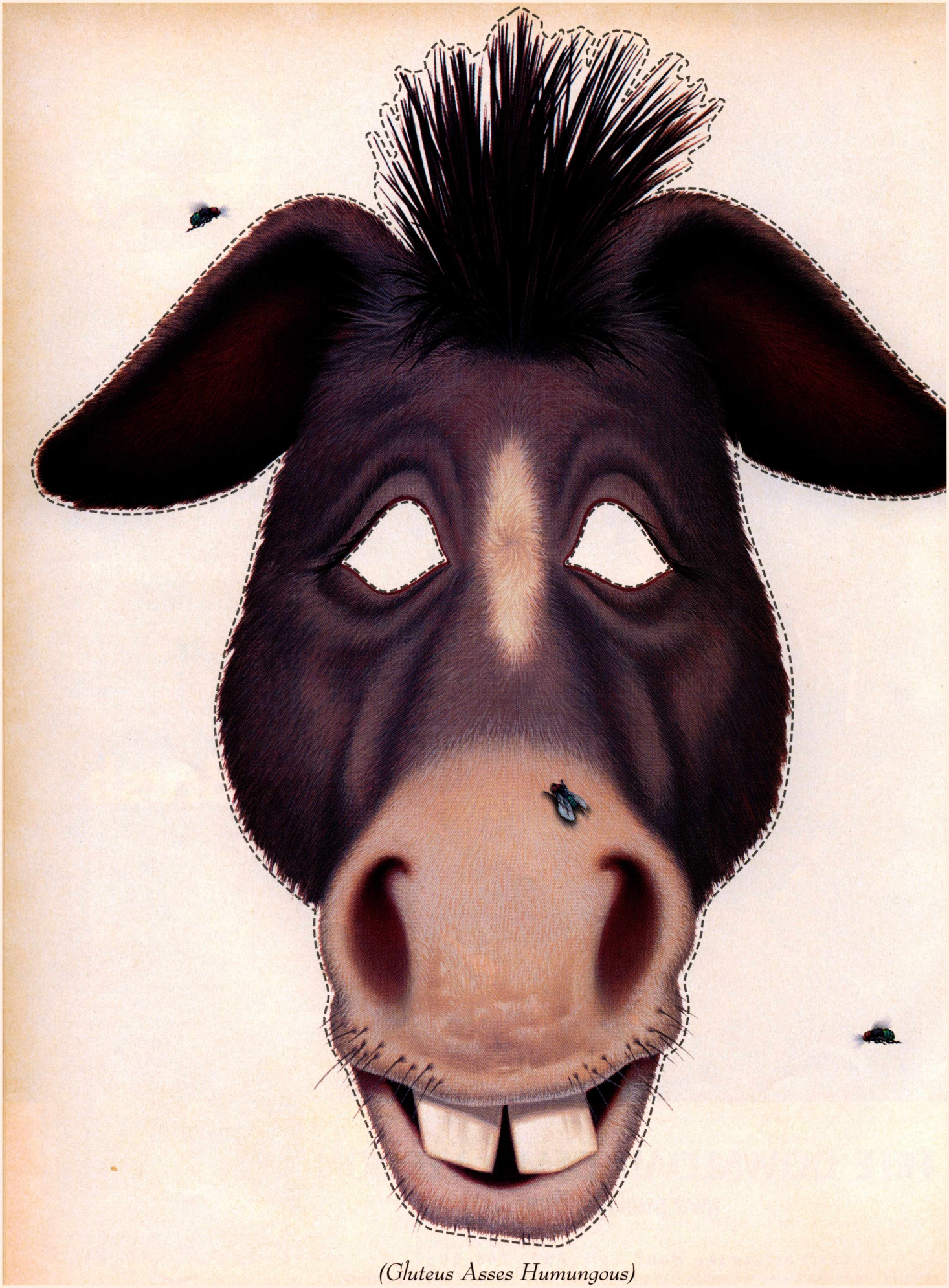

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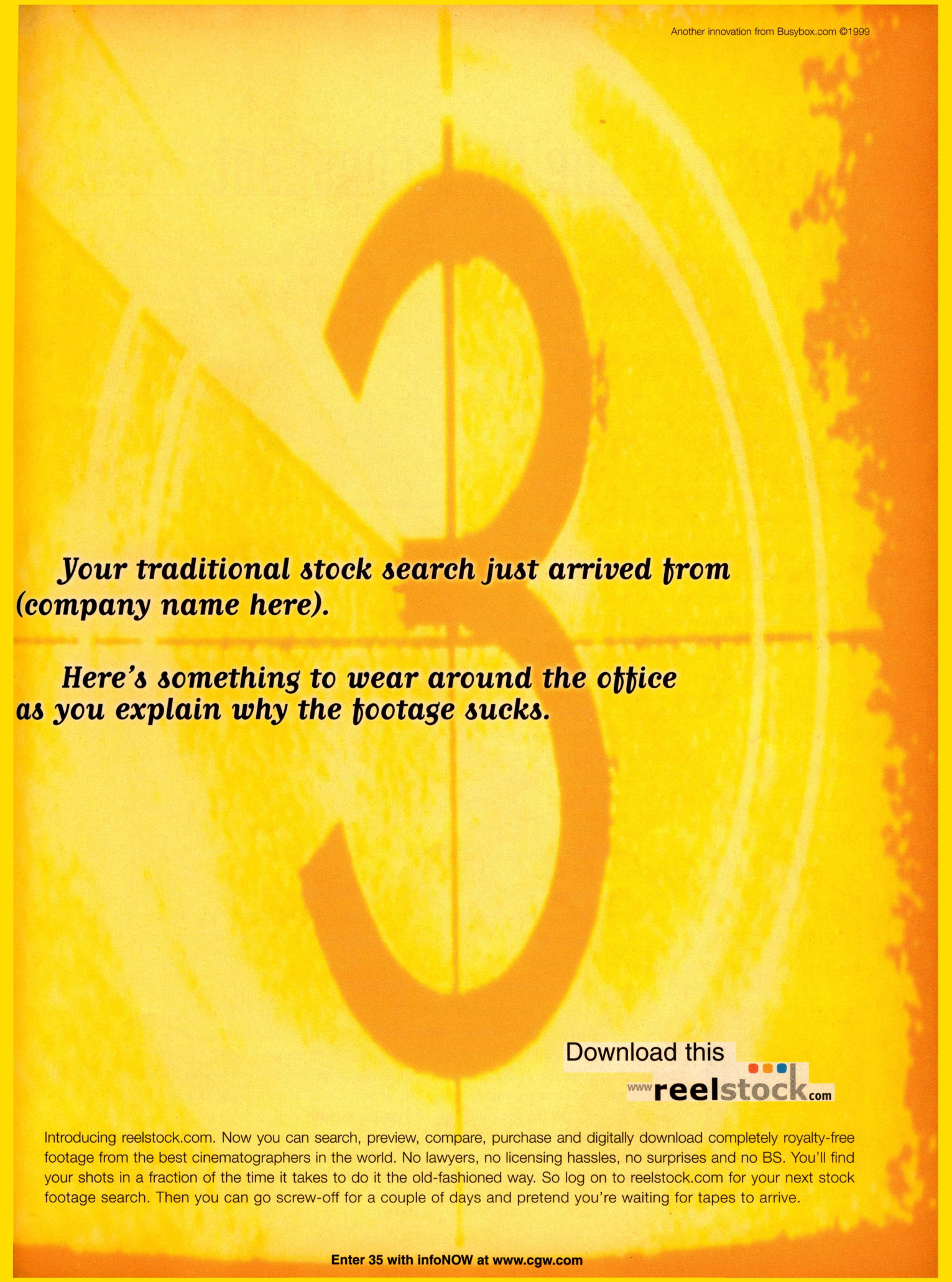

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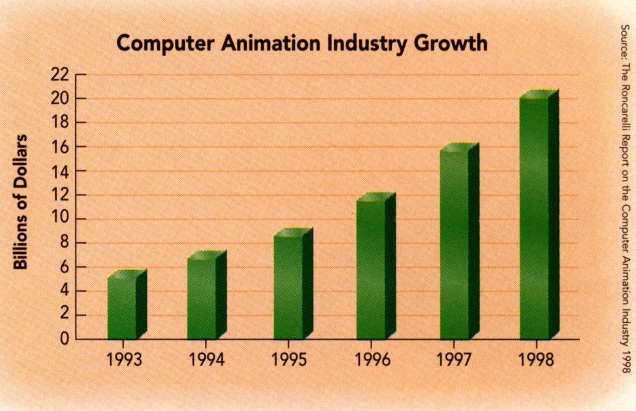
Growth is the Only Constant

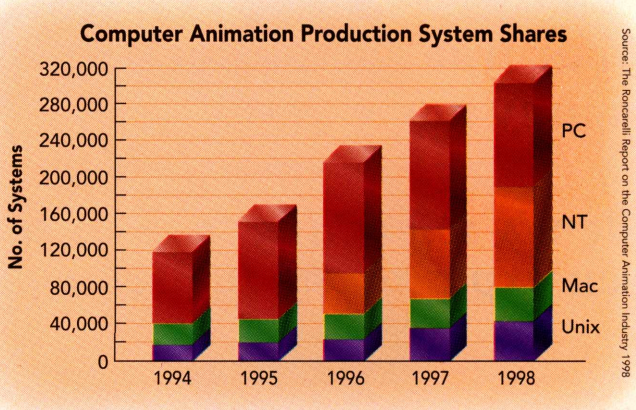
Though the computer animation industry's 29% growth in 1998 was lower than its 35% margin in 1997, the surge in revenues from $15.8 to $20.3 billion during that period was impressive. But while overall growth remains constant, change is rampant within the industry itself.

A major part of this dynamism is a shift in the computing platforms used by animation producers. While 1998 showed a rise in the use of all platforms, their relative ratios are changing, with NT growing faster than the others, Unix showing modest growth, and the Macintosh holding its own.

The major force behind the demand for computer animation is the entertainment industry. As the use of computer-enhanced imagery increases, the public's demand for it seems to increase as well. Indeed, production for various entertainment segments accounted for more than 70% of all animation volume last year.



Computer animation revenues jumped nearly 30% in 1998 to top $20 billion.

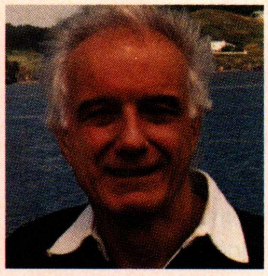


NT platforms surged, PCs shrunk, and Mac and Unix systems remained steady.

Shifting Platforms

The increasing importance of the NT platform (a trend carried over from last year) is clear, as its share of computer animation workstations increased from 28.5% in 1997 to 35.4% in 1998. Surprisingly, Macintosh basically held its own, dropping from 12% to 11.9% during the year, and the Unix platform's share increased slightly, from 14.7% to 15.4%. The rise in the use of Unix workstations can be attributed to the demand for high-end SGI Unix-based systems for film production. Also, several large companies continue to rely almost entirely on SGI Unix-based platforms because of their investment in proprietary computer animation code for the platform. The one platform that has lost shares in the past year is the PC/Windows category, sliding from 44.8% in 1997 to 37.3% in 1998.

The computer animation industry shows solid growth, but the systems of choice are like shifting sands



ROBI RONCARELLI

Many are touting the potential of the Linux operating system for computer animation. But so far, there has been only limited movement to port mainstream computer animation software to the OS. Thus, it is not likely that Linux will be a major factor in the industry.

So what's ahead? We expect the industry percentage to strengthen in 1999 as major new movie projects using computer graphics get green-lighted. And during the next few years, we expect to see the NT platform continue to increase relative to the PC/Windows platform, with the Macintosh and Unix percentages remaining relatively static.

One factor behind future growth is the ease of entry into the computer animation production industry brought about by affordable and powerful NT workstations. Consequently, smaller production houses are popping up, and they are helping to meet the increasing demand for effects-driven entertainment. These conditions will ensure that the overall industry growth trends we see in 1998 will continue over the next several years.

Robi Roncarelli is publisher of "The Roncarelli Report on the Computer Animation Industry 1998," from which this article is adapted. He can be reached at pixel@inforamp.net.

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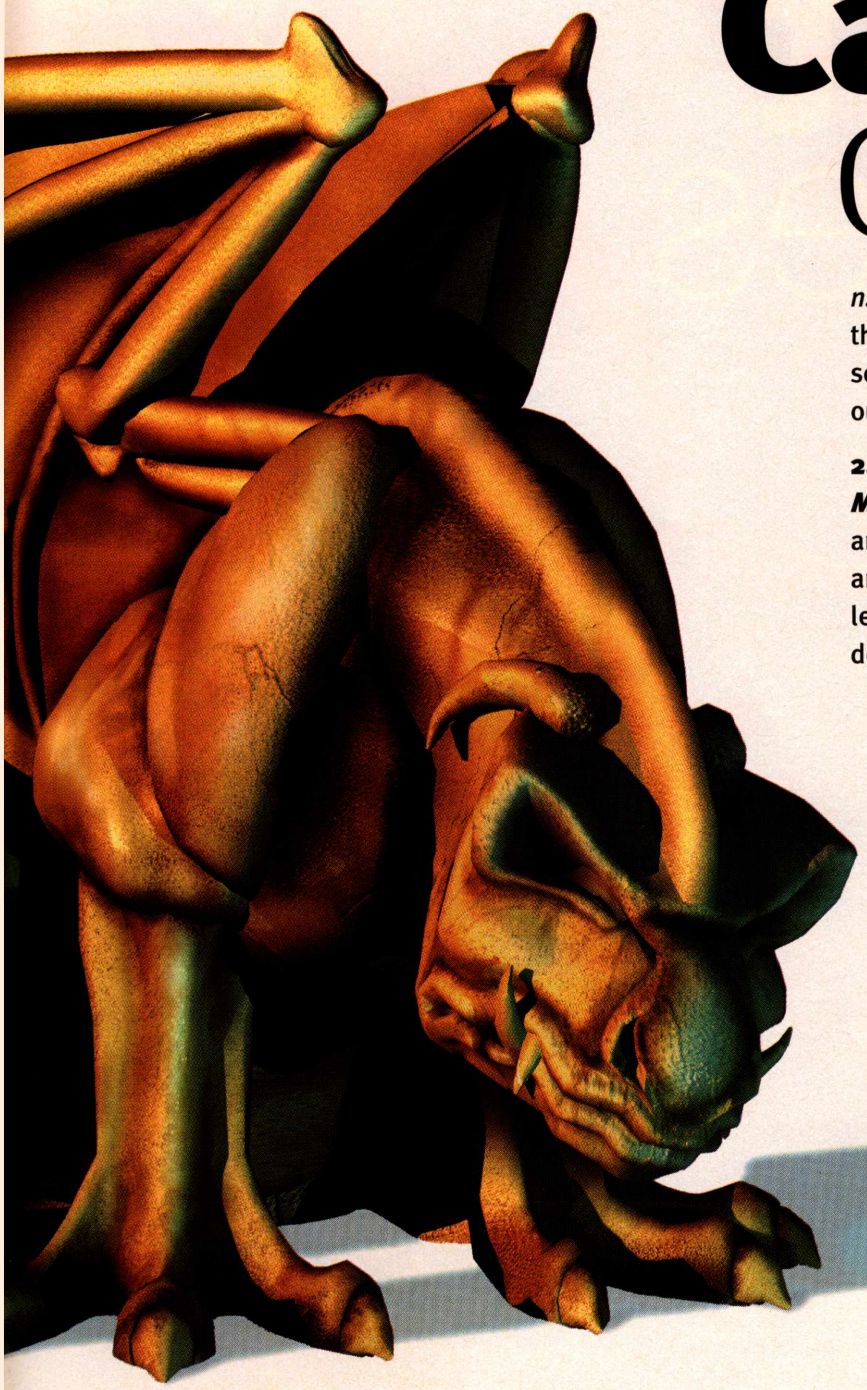

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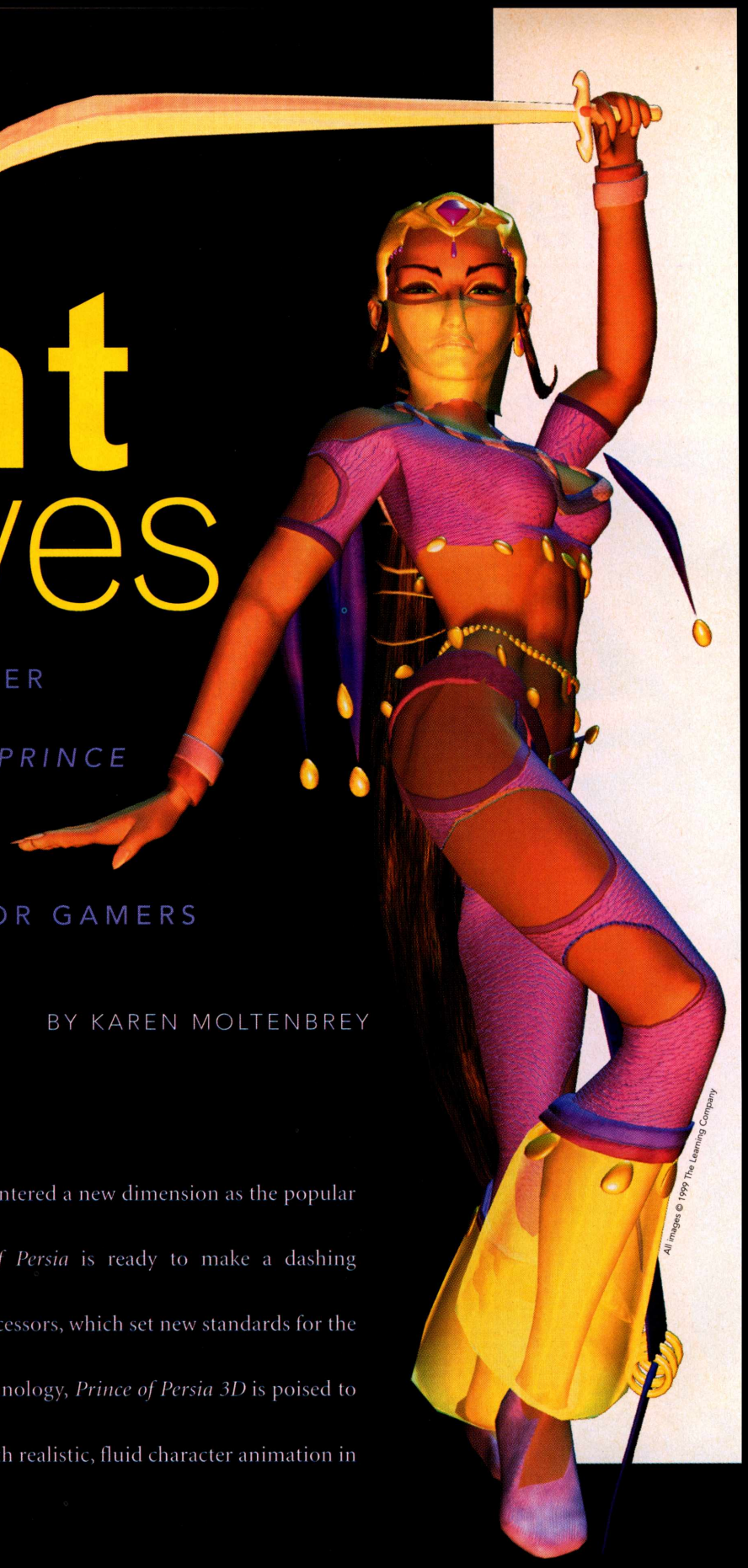
all the right moves

REALISTIC CHARACTER ANIMATION MAKES *PRINCE OF PERSIA 3D* A TREASURE TROVE FOR GAMERS

BY KAREN MOLTENBREY



All images © 1999 The Learning Company

Life in 12th-century Persia has entered a new dimension as the popular 2D computer game *Prince of Persia* is ready to make a dashing entrance into 3D. Like its royal predecessors, which set new standards for the gaming world with leading-edge technology, *Prince of Persia 3D* is poised to once again storm the marketplace with realistic, fluid character animation in a rich graphics environment.

Prince of Persia 3D contains exotic Middle Eastern environments and sword-brandishing action, picking up the story line where *Prince of Persia 2: The Shadow and the Flame* concluded.

"Like the two previous releases, the new game is a love story in which the imprisoned prince has to escape and rescue the kidnapped princess. But it's the journey of the prince as he moves through the game's seven environments that makes the play so compelling," says Andrew Pedersen, executive producer. "In *Prince of Persia 3D*, the characters move fluidly and realistically through an exotic, rich environment filled with a high level of interactivity. We didn't sacrifice the imagery to achieve hot effects or game play—it's all there."

In 1989, Jordan Mechner introduced the world to *Prince of Persia*, which popularized many computer-gaming features now taken for granted, such as rotoscoped animation, which resulted in lifelike human motion. So popular was the first game that it was ported to just about every possible gaming platform, while selling almost 2 million copies. In 1993, Mechner designed the second title, which also won accolades throughout the industry for its high-end animation and design.

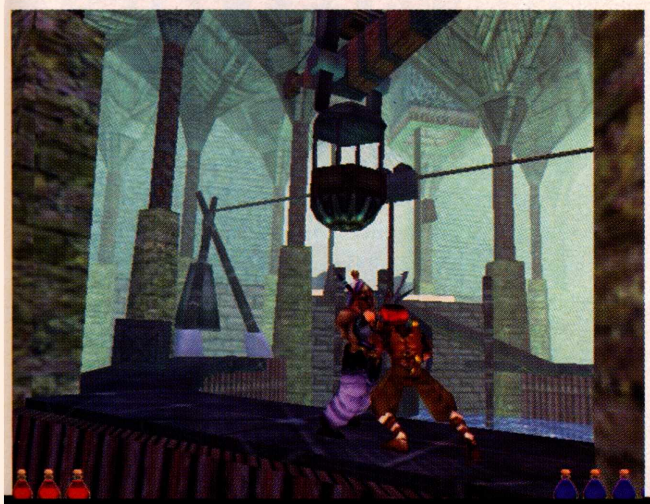
More than two years ago, Mindscape (Novato, CA) began full-scale development of the latest version, with Mechner acting as design consultant. The third-person action game, published under the Red Orb name, is being released this fall for the PC platform.

"We periodically looked at doing a 3D version, but we never felt like the technology—on the software and hardware sides—had reached a point where we could make the kind of game we thought would be worthy of a sequel," Pedersen says. "With the proliferation of hardware accelerators and PC horsepower about two years ago, we felt the time was right to make our mark."

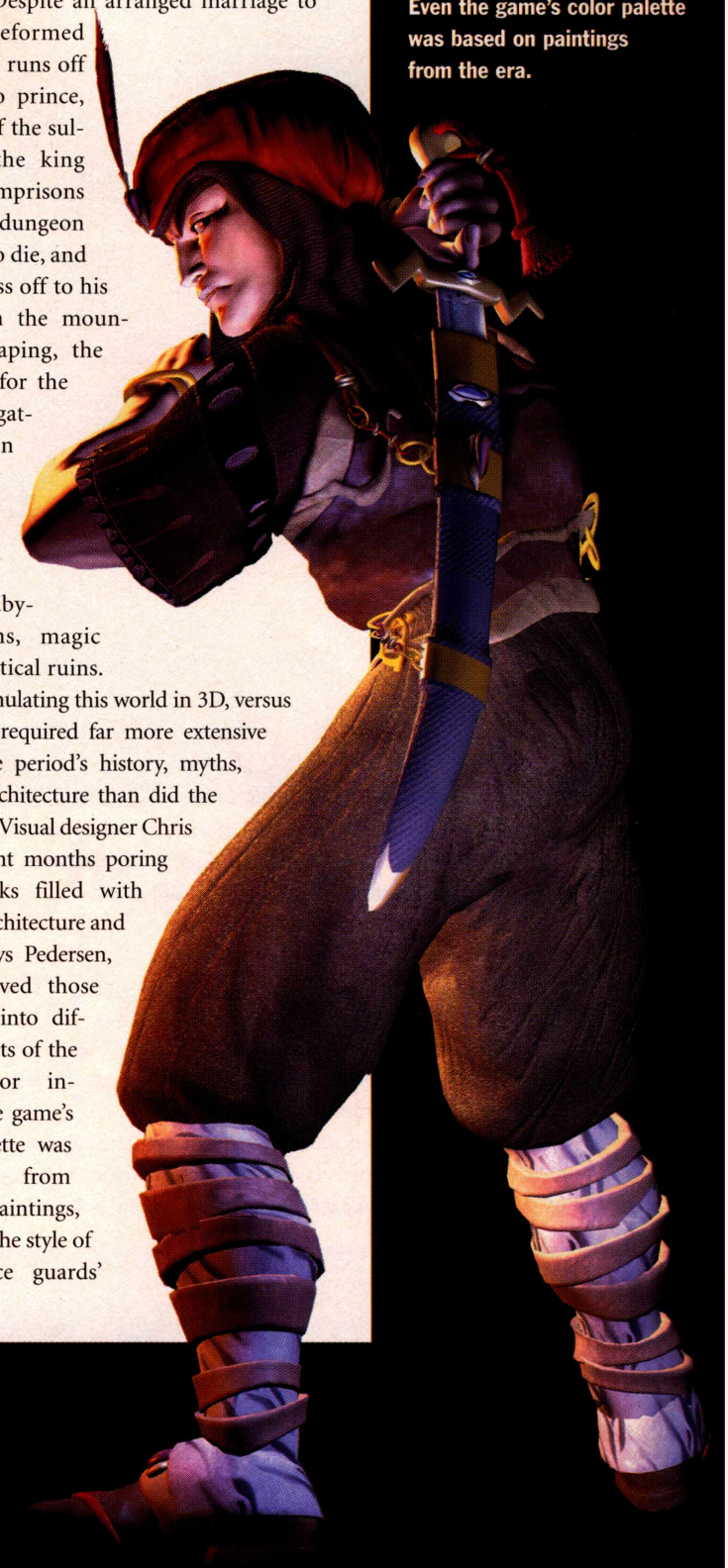
Back in Time

Prince of Persia 3D, like the two releases before, resembles an *Arabian Nights* tale in both imagery and story line. Despite an arranged marriage to King Assan's deformed son, the princess runs off to wed the hero prince, who is the son of the sultan. Enraged, the king traps the pair, imprisons the prince in a dungeon where he is left to die, and sends the princess off to his son's fortress in the mountains. After escaping, the prince searches for the princess by navigating through an exotic 12th-century environment, complete with ornate palaces, labyrinthine caverns, magic carpets, and mystical ruins.

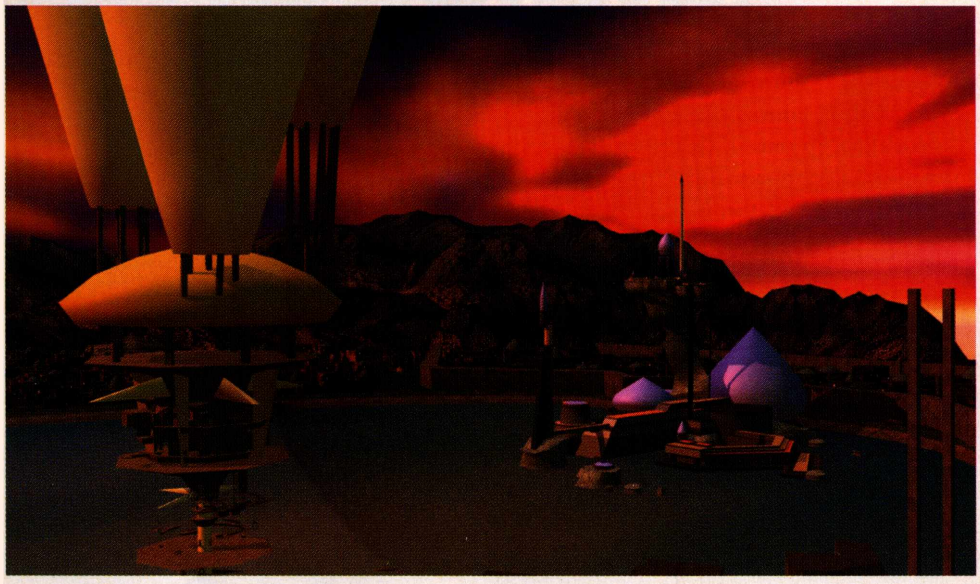
Accurately simulating this world in 3D, versus a flat 2D plane, required far more extensive research into the period's history, myths, paintings, and architecture than did the preceding games. Visual designer Chris Grun spent months poring over books filled with Persian architecture and myths, says Pedersen, then weaved those elements into different facets of the game. For instance, the game's color palette was adapted from Persian paintings, and even the style of the palace guards'



Rather than rushing the Prince of Persia series to a 3D platform, the developers waited until the technology was available that would allow them to release a game with graphics and motion befitting the prince's birthright.



Designers spent months researching 12th-century Persia, then weaved details from their findings into the clothing and architecture found in *Prince of Persia 3D*. Even the game's color palette was based on paintings from the era.



Although the game's exotic architecture is based on historical fact, the designers added their own artistic interpretation to make the environments even more lush and dramatic.

uniforms was based on historical reference.

"It is important that the players believe they are in a real Persian environment, so historical reference was vital in creating the look and feel of the worlds," Grun says. "Using this vast research, the development team has adapted the ancient to give it a more contemporary spin."

To provide an even more distinct flavor to the game, architects with a passion for Persian construction helped design some of the game spaces. As a result, when the prince is exploring a palace, "you feel like you are in an opulent Persian palace, not a generic castle," Pedersen maintains. However, the game's architecture does stray somewhat from the realistic to the stylistic. "Graphically, we tried to push the envelope by contemporizing the look, so it is not a historical-looking game—you will not say, 'I have seen that palace in a book.' Rather, it reflects our stylistic interpretation."

Once inside these environments, the prince can explore 13 exotic levels as he fights to free himself from prison and rescue his princess. In his adventures, the prince encounters numerous surprise traps, puzzles, and combat situations characteristic of the previous 2D versions, but the 3D technology lends more realism to the imagery and play. "We took advantage of the camera so the field of view communicates additional drama but also helps direct the player as he navigates the 3D world," Pedersen explains.

Persian Construction

To build the models of ancient Persia, the artists mainly used NewTek's LightWave 3D. For the construction of the game levels, including lighting, texturing, and scripting of the objects (such as door and trap movement and collapsing floors), the group used Discreet's 3D Studio Max running on a Windows NT platform.

The real-time game rendering was accomplished with the NetImmerse 3D game engine from Numerical Design, which provided the animators with a variety of special effects, including shadow casting, dynamic lighting, and particle generation. "It has a complete architecture that we molded to fit our needs," Pedersen says. "We were able to work on the game play from day one without worrying about developing the underlying 3D game engine," saving months of precious development time.

NetImmerse's role in *Prince of Persia 3D*, in fact, was quite large. The group used the technology throughout

Using LightWave 3D, the artists created finely detailed images, such as this mythical creature, to populate the game environments.

PRINCELY TOOLS

3D Studio Max	LightWave 3D	Motivate	NetImmerse
Discreet	NewTek	Motion Factory	Numerical Design
Montreal	San Antonio, TX	Fremont, CA	Palo Alto, CA
514-393-1616	800-847-6111	510-505-5151	650-328-4388
www.discreet.com	www.newtek.com	www.motion-factory.com	www.ndl.com
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the entire development process for scene and texture management, geometry processing, dynamic collision, and detection. Because NetImmerse is not limited to game level- or terrain-based graphics, the developers were free to integrate indoor and outdoor environments—from dark foreboding dungeons to a bright sunny palace—without limitation.

Prince of Moves

For the character animation, the developers used Motion Factory's Motivate Intelligent Digital Actor system, which delivers the fluid, realistic movement for which the 2D titles were known. "We think it's important that our characters move more realistically than the competition's because that's what players expect from a *Prince of Persia* game," Pedersen says.

To achieve the smooth motion of the prince in the original release, Mechner videotaped his brother performing rolls, leaps, and the prince's famed slides, among other actions, then hand-traced each movie frame. After the figures were imported into his Apple II, Mechner revised each frame to resemble the various characters appearing in the game. While this process proved especially tedious, it resulted in breakthrough fluid animation.

For realistic character movement, the developers used Motivate, which employs inverse kinematics to smoothly transition from one action to the next. Movements can also be combined, so a character on the run can also grab an object.

For *Prince of Persia 3D*, the animators took a similar approach. Rather than manipulating large quantities of motion-capture data, they videotaped and digitized a top-ranked gymnast performing the main character's moves, which served as a guide for keyframing the movement into Motivate. "This provided us with the necessary subtleties of human motion," notes Pedersen.

The Motivate system endows the prince with an innate knowledge of his physical limitations and his environment, allowing the character to maneuver around obstacles and manipulate objects naturally. This ability is provided through the technology's real-time motion synthesis, which generates character motion on the fly in response to a dynamically changing environment, and dynamic event-based behavioral programming for creating the characters' sophisticated game logic.

The result of using the Motivate technology is complex hand combat within the game play, says Pedersen. Unlike most other computer games, where the player haphazardly pushes a button to fire a weapon, *Prince of Persia 3D*'s combat requires strategy and finesse because the sword-like weapons are programmed to simulate actual capabilities, even taking into consideration distance issues. To be successful, the player must know the potentials and limitations of his weapon when engaging the enemy.

"The swordplay is predicated on real sword-fighting tactics, so blocking is just as important as striking; you can't win if you're dead," Pedersen says. To more realistically simulate the swordsmanship, Mindscape contracted a fight choreographer and taped two actors performing a variety of fencing moves, which was used for animation reference. "It provided us with some of the subtleties of human motion without the limitations of motion capture, such as data-manipulation problems and the physical limitations of a performer," he adds.

While the 3D venue enabled the developers to introduce more elaborate graphics and action to the series, "the complexity of the development increases exponentially," Pedersen says. Because the prince has more freedom and range of motion in 3D, it becomes more difficult to "corral" the player to keep him on the desired game path. "As the player successfully navigates the perils and traps in the game, his immediate objective should always be visible and clear," says Pedersen. This is accomplished through camera cuts, strategic lighting, and various movements, such as the opening and closing of doors.

To successfully run *Prince of Persia 3D*, a player must have a minimum of a 233MHz MMX PC running Windows 95 with a 3D graphics accelerator.

For many loyal fans, *Prince of Persia's* move to 3D was a long time coming. But for the game's developers, the time had to be perfect. "The fans of the previous releases are going to be pleased because *Prince of Persia 3D* is true to the originals. Yet its high level of interactivity and action will also please hard-core gamers," Pederson says.

Karen Moltenbrey is an associate editor at Computer Graphics World.

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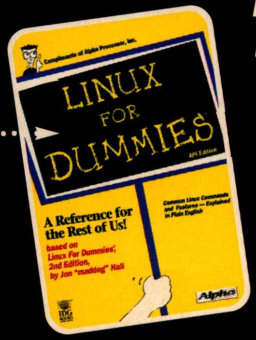

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3D ON THE WEB

3D-ENABLED WEB SITES BEGIN TO MAKE ECONOMIC SENSE

BY BARBARA ROBERTSON

As a medium for various forms of entertainment, for gathering and sharing information, and for collaboration and communication, the Internet has become such a success that for many people it's indispensable. The question that typically follows a declaration that a Web site is successful, though, is, "Fine, but is it making money?" And the typical answer is, "Not yet, but...."

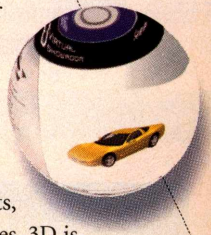
Thus, it's no surprise that e-business and e-commerce—in particular, shopping, which has a clearly defined bottom line—are the applications getting the most attention from investors. Why does this matter to people involved with computer graphics? It turns out that e-commerce sites are beginning to use 3D graphics to differentiate themselves, keep people on the site, and help sell products.

To create this car, Viewpoint Digital used 3D Studio Max and Softimage; to display it on www.autobytel.com, it used Metastream.

Although the Internet has played host to a few successful 3D Web sites—game sites, virtual communities (some populated with avatars), the occasional forward-thinking sports/entertainment or high-tech site, the Web has largely remained a flat land created with still or moving 2D images. That's beginning to change. E-commerce sites that tempt viewers to step into a 3D world and interact with something, if only through a small window on a 2D HTML page, have begun to appear online.

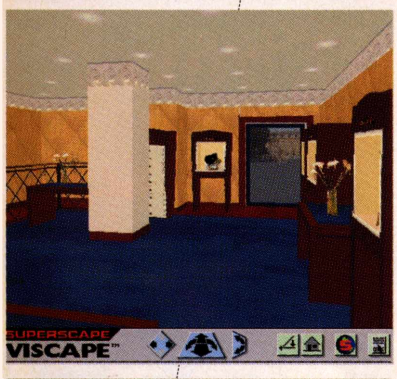
"We're just at the beginning of 3D in e-commerce," says Linda Hahner, vice president of marketing for the Web3D Consortium, which spearheads work on VRML (virtual reality markup language), a standard used by many Web developers for 3D objects and worlds. "I see e-commerce driving 3D onto the Web."

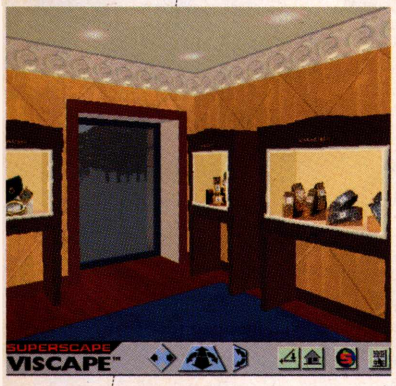
3D graphics on e-commerce sites usually appear in one of three forms: 3D models that help sell individual products by letting people "try out" the 3D representations in a window; 3D cartoon characters that add spice to sites and banners; and virtual worlds that invite people to design kitchens using a manufacturer's appliances, pick out a seat in a coliseum on a ticket-selling site, and check out the shops in a virtual mall or along a street in a virtual city. In addition, Sandeep Divekar, vice president of visualization at Computer Associates (Marina del Rey, CA), predicts that companies will use interactive 3D models for product support on Web sites.



"For Web designers and developers, 3D is just another Web component," says Wanda Meloni, a senior analyst with Jon Peddie Associates (Tiburon, CA) who specializes in graphics software. "As more Web designers feel comfortable with the other components, they're starting to look at 3D as a way to differentiate sites. 3D is the last media component they have to work with."

The factors enabling this movement of 3D onto the Web are new Web 3D tools for developers, higher bandwidth going to the home, and lower prices for 3D-enabled PCs with fast processors—especially Intel's Pentium III. Its streaming SIMD extensions facilitate the transfer of rich con-





Using Superscape's 3D Webmaster, Citycom created www.galeries-versailles.com, a shopping mall in Paris.

tent such as 3D over the Web, and Intel has budgeted $300 million for marketing to help convince people they want it. Already, Intel can point to several Web sites, many of which are 3D enabled, that have been optimized for the PIII. (See www.intel.com /intel/showcase/guide/index.htm.)

Two of these sites in particular are attracting a lot of attention: the Sharper Image and Styleclick sites. On the Sharper Image site, people can rotate and interact with 3D products from the store's catalog. On the Styleclick site, shoppers can rotate and zoom in on 3D clothes and accessories from various fashion designers.

Looking Sharp

Sharper Image is a San Francisco-based company known for selling high-tech gadgets, primarily through retail stores and mail-order catalogs, and, like many such retailers, the company has put its catalog online (www.sharperimage.com). This year, it put 25 products online as interactive 3D models—items such as a motorized CD rack, a turbo nose-hair groomer, and a CD player for the shower. The company contracted with Viewpoint Digital (Orem, UT) a division of Computer Associates (New York) to develop the content. Viewpoint used Shells Interactive's (Los Angeles) 3D Dreams to give the models created at Viewpoint interactive "behaviors," and chose Metastream.com's (Carpenteria, CA) Metastream technology for viewing.

Sharper Image's 3D products debuted in March. In June, the company's online sales nearly equaled last year's December (Christmas) online sales, according to Meredith Medland, director of Sharper Image's Internet Division. "The 3D content has pulled up our overall number of page views by 300%," she says. "We've found that people spent 50% more time in the 3D area." The increase in viewing time and page views is apparently translating into increased revenue: Last year, Sharper Image's online revenues were $4.9 million; this year, the projection for online revenue is $30 million, according to Medland.

"For first time in our history, we have something that's better than a print catalog," says Richard Thalheimer, Sharper Image chairman and founder. "Last year, all we had were pictures. Now, you can open up a product, click it apart, turn on the light, rotate it. You get the fun of understanding what the product is like before you order."

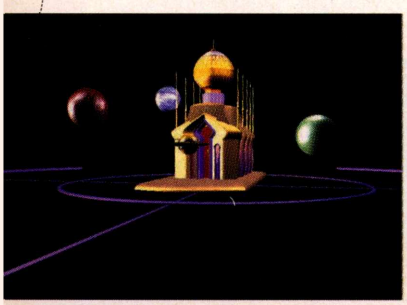
On the site for Styleclick.com Inc.'s (Culver City, CA), about 10% of the products are now 3D, according to Linda Freedman, vice president of marketing. Styleclick.com, formerly known as ModaCad, has drawn on its CAD visualization technology to recast itself as a shopping network and e-commerce enabler for fashion and home-furnishings manufacturers, many of whom are former customers. Styleclick.com now handles everything from front-end visualization to back-end order fulfillment, to the syndication of product lines for other Web sites.

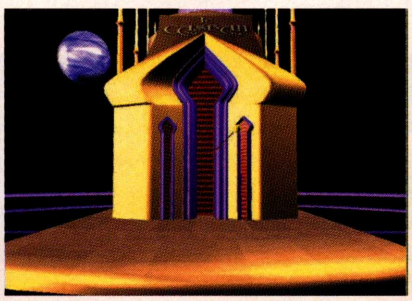
Image courtesy of TicketMaster.

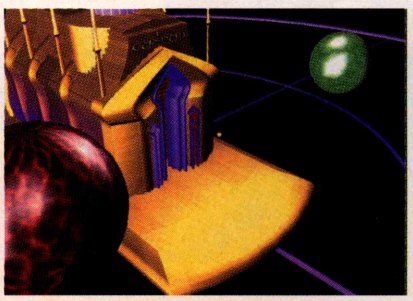
Viewpoint re-created the Georgia Dome in 3D, using 3D Studio Max, Cosmo Worlds, its own VRML tools, and blaxxun's VRML browser to help patrons pick seats on TicketMaster's Web site.

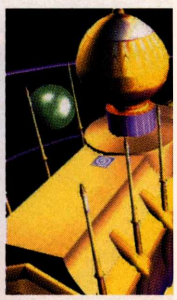
Manufacturers send merchandise or designs to Styleclick, where the products are photographed and, in some cases, turned into 3D models. Styleclick uses its proprietary software for scanning, fabric draping, and rendering. For viewing, it chose Metastream. On Styleclick's own site, www.styleclick.com, which launched in April, people can search through collections of clothing, accessories, and shoes using criteria such as price.

"We have about 100 manufacturers on the site, with 240 in process," says Freedman who estimates that about 10% of the thousands of products on the site are now 3D, and some manufacturers are about to use 3D for all their products. "Anything









At www.sharperimage.com, 25 products are now interactive 3D models created at Viewpoint. Viewpoint used Shell's 3D Dreams to make the models interactive, and Metastream for viewing.

that can offer the consumer something other than a small thumbnail photograph, whether it's 3D or something else, can help them sell their products."

On both of these sites, the 3D objects have been inserted in HTML pages. Both sites are primarily 2D, and the tools chosen to create the interactive 3D components handle individual 3D objects, not virtual worlds. "We recognize that's where people are starting now," says Steve Timmerman, vice president of marketing at Superscape (Santa Clara, CA; Hook, Hampshire, UK), a VRML developer that has been building virtual worlds for 12 years. "We haven't competed in 3D object visualization, but we'll be there," he adds. "And then we'll be able to bridge from the low end to the high end."

At the high end, Superscape's "content solutions group" has 150 applications to its credit. The most recent example of its e-commerce Web work is a site created for Whirlpool that lets people design a kitchen in 3D using Whirlpool appliances (www.whirlpool.com) that's viewed using the company's Viscape player.

3D Web Tools

Despite the success of sites such as these and the efforts of the VRML community, now known as the Web3D Consortium, VRML on the whole has not been a clear winner. "VRML is obviously not a success," Meloni states, "but in the larger perspective, its downfall is a positive thing because it's caused developers to focus on solving key problems rather than on developing standard formats." She predicts that next year, about a quarter of all Internet tools will have 3D capability. Already, some interesting ideas are emerging as VRML developers try to be competitive, the Web 3D Consortium readies its next generation VRML spec called X3D (www.web3D.com), and companies with proprietary solutions try to leapfrog each other with big features, small file sizes, and speed. Here are some examples:

- **Blaxxun interactive's** (San Francisco; Munich) blaxxun3D, a compatible subset of VRML97 implemented in "native Java," creates objects that appear on Web pages with no download or installation. A programming language lets developers integrate the applet with Web pages. Also, the source code for blaxxun's VRML browser is now open and available from the Web3D Consortium under a Community Source license.
- **Brilliant Digital's** (Woodland Hills, CA) B3D Max compresses animations created with 3D Studio Max into small, Web-enabled files. B3D Studio adds automatic lip synch, interactivity, character gestures, and a library system. B3D files require Brilliant's Digital Projector plug-in.
- **Caligari's** (Mountain View, CA) new iSpace allows Web-site developers to create and render 3D graphics and animations, add them to a 2D page created with HTML editors such as Front Page, and output the 2D result as HTML.
- **Cyberworld** (Mississauga, Ontario) offers a unique viewer/builder/browser for creating interactive virtual worlds from photographs.
- **Cybellius's** (San Jose, CA; Espoo, Finland) ShowMore puts 3D VRML models in HTML pages; TouchMore, a Java-based tool, adds behaviors to the models.
- **Cycore's** (San Mateo, CA; Uppsala, Sweden) Cult3D Player supports high-level rendering and lighting such as Phong shading, yet creates 3D models compressed to between 20K and 200K that can be streamed over the Internet and viewed via a Cult3D browser plug-in. Cult3D Designer adds interactive functions, sound, and Java code to models exported from 3D Studio Max. Cycore gives its software to artists, charging a license fee only for models that are distributed.
- **Duran Duboi** (Paris) used its own Mendel 3D to create a real-time 3D Web animation that mimicked yachts during a race by using telemetry data sent from the boats to control their movement. An extrapolation of NURBS technology, Mendel3D objects are defined by geometrical coordinates and dynamic parameters (mass, elasticity, gravity, etc.). The software supports multiple cameras and animatable procedural textures.
- **Metastream.com's** (Carpenteria, CA) Metastream is an open file format for scalable 3D that compresses data and delivers the view. With

By selecting "Cool Views" on the www.styleclick.com site, you can look at clothes, shoes, and accessories from any angle.

An open-source initiative for real-time 3D on the Net, Ur Studios' Gel adds curved surfaces to models and streams behaviors between machines.

Metastream, a 3D object "streams" into view; that is, the rendered quality of the object improves as you wait, even though you can begin interacting with the object in simple ways as it streams in.

- **Mitsubishi Electric's** (Waltham, MA) Schmoozer is a JAVA-based authoring tool that can be used to create social and collaborative 3D spaces on the Web.
- **NeMo's** (formerly Virtools; Paris) NeMo Creation allows non-programmers to graphically add behaviors and interactivity to 3D models and scenes to create real-time 3D environments. It supports synchronized integration with Macromedia's Director and works with models from most Windows NT-based 3D animation software programs.
- **Pulse Entertainment's** (San Francisco) Pulse Creator is an authoring system; Pulse Player is a browser plug-in. The software supports bendable objects, lip synch with audio streaming, polygon reduction, and scripting for behaviors.
- **Shells Interactive's** (Los Angeles) 3D Dreams continues to add interactive 3D capability to Macromedia's Director; the 3D Dreams Player automatically downloads and scales to the user's system.
- **Shout Interactive's** (San Francisco) Shout3D enables Web browsers with Java Virtual Machine (JVM) to display interactive 3D graphics without special plug-ins. Shout3D offers keyframed animation, physics, texture-mapped polygons, limited raytracing, directional lighting, transparency, hierarchical models, and extensibility via APIs. Shout Interactive has proposed to the Web 3D Consortium that Shout3D's object model and API be used for X3D.
- **Superscape's** (Santa Clara, CA; Hook, Hampshire, UK) authoring packages, VRT, 3D Webmaster, and Do 3D, provide support, information, and training for creating VRML-based or SVR-based 3D Web pages viewable with its Viscape 3D browser plug-ins; the company's virtual Web site (vwww.com) has links to 600 3D Web sites.
- **Ur Studios** (Santa Monica, CA) is shepherding Gel, an open-source initiative aiming to define a platform for efficient, interactive, non-polygonal, multi-user 3D on the Internet. Gel is based on peer-to-peer networking, adds curved surfaces to polygonal options, and streams world parts and behaviors between machines on a continuous, as needed basis to allow real-time, shared authoring and editing of 3D worlds. The underlying components of the system—the scene graph, object hierarchy, behaviors, and communication network—are graphs. GEL was scheduled for release in September.

As anyone who's tried looking at 3D-enabled Web sites knows, many of the VRML sites work with a standard VRML viewer such as the one included with Microsoft's Internet Explorer 5.0. However, once you leave VRML, most solutions require specific plug-ins or players/viewers which must be downloaded and installed. Some work only with Internet Explorer. Some work only with Intel-based machines. Some don't work with each other. This can be painful for users. And although Web site designers will keep encouraging experimentation by vendors, the software that results may not be as complete or stable as the designers need. Will this mean that ultimately everyone will join in and work toward Web 3D standards? Probably not.

As Martin Plaehn, CEO of Viewpoint Digital puts it: "It's not a simple problem. I don't think standards can be set from the outside in. I think the lab is the Web itself. The sites with the most traffic will pull the standards through."

Barbara Robertson is West Coast senior editor for Computer Graphics World.

3D WEB TOOLS

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Turning expertise with real-time animation into a Web-based business, Protozoa licenses its DotComix, such as Gates of Hell, to other Web sites. Protozoa (www.protozoa.com) uses the Pulse player.

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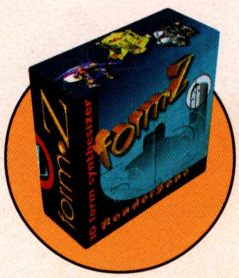

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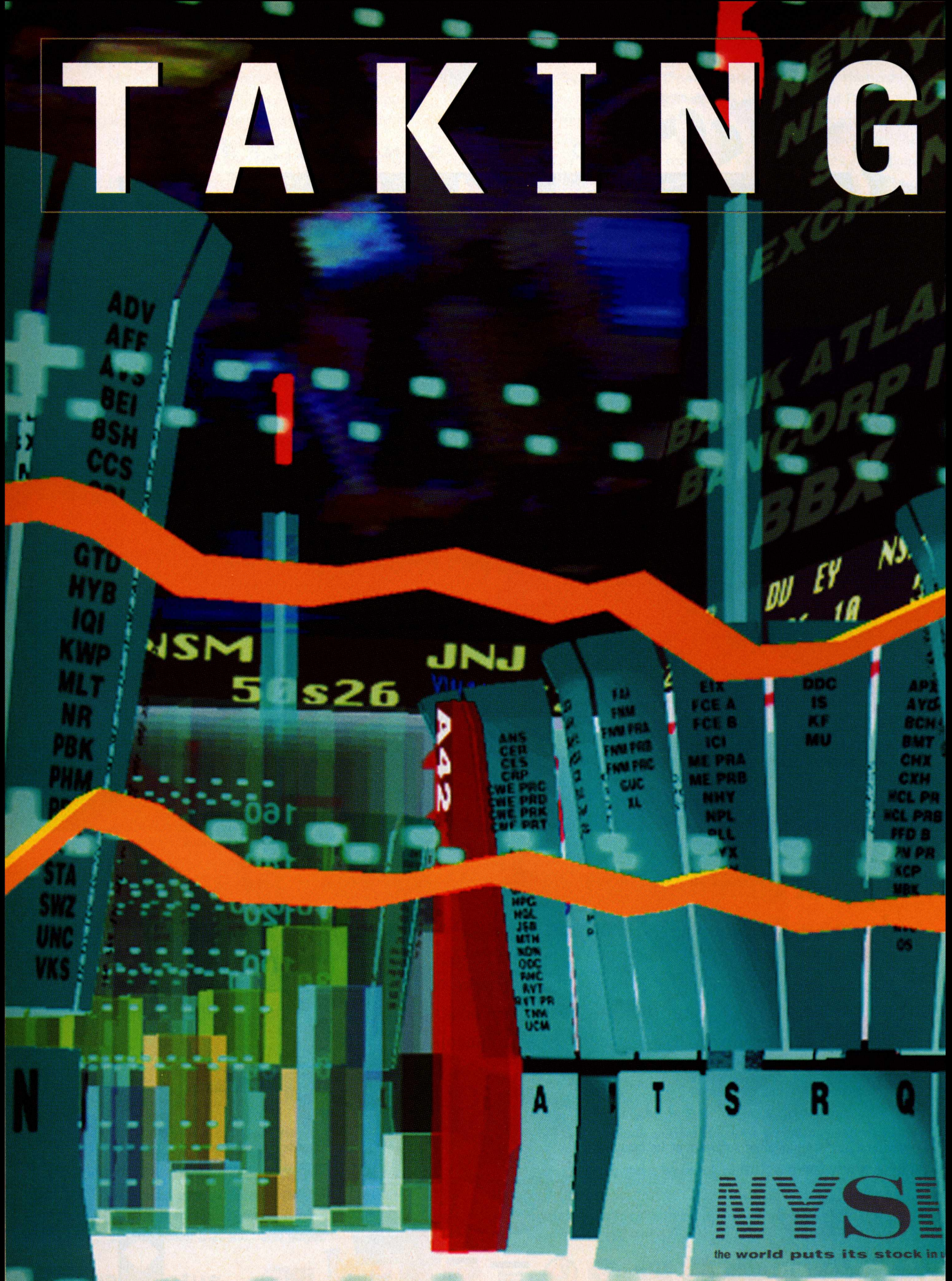
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STOCK

THE NEW YORK STOCK EXCHANGE ADDS A NEW DIMENSION TO WALL STREET WITH A 3D TRADING FLOOR

BY KAREN MOLTENBREY

At the New York Stock Exchange (NYSE), an average of $38 billion in trades occurs daily, creating a situation where literally every second counts, as buyers and sellers interact and compete for the best possible equity prices. Not only must the Exchange track pertinent information for the approximately 3100 listed companies, it must also monitor those businesses' combined 260 billion shares of stock, totaling more than $15 trillion in global marketing capitalization, that can be bought and sold daily through the NYSE. To help take stock of this situation, the NYSE launched its Three-Dimensional Trading Floor in the Exchange's advanced operations center, which uses 3D computer graphics to monitor and interpret all the NYSE's business and systems activity in real time.

Using the virtual landscape, the NYSE operations unit can intuitively observe stock and systems activity related to trading, and respond to events with more information and at a faster rate than previous 2D monitoring systems allowed. By presenting the activity visually in three dimensions, the NYSE gains a significant time advantage for response to trading issues.

"We built an operations management tool," says Anne Allen, vice president of floor operations. "We're using icons, animation, and color to represent events that trigger alarms, and that tell us what's going on, without us having to query databases to find that information. In a very visual way, we know what is going on [throughout the stock exchange trading floor]."

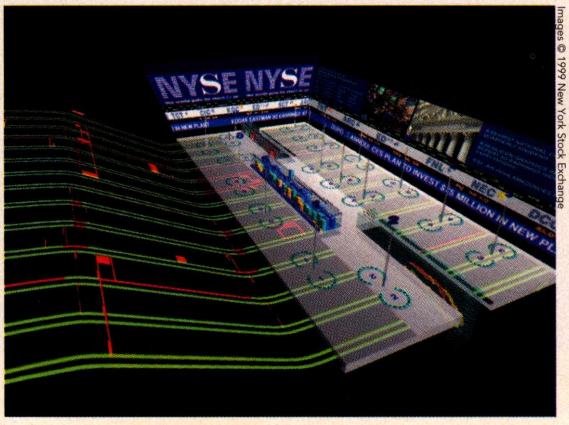
With CG imagery, the NYSE floor operations group has consolidated continuous data streams from the Exchange's trading systems (trades, orders, quotes, report information, and systems information) into one three-dimensional system. In turn, the new system has completely revolutionized the way the NYSE's operations staff—and other users—monitor and interpret the Exchange's business and systems activity.

According to Allen, the interactive 3D model is a physically and geographically accurate representation of the trading floor. Each stock contains 30 to 40 attributes that can be represented on the labels inside the model and on various information surfaces within the model, including virtual tickers and 3D graphs. Using this interactive 3D virtual trading floor, the operations staff can visualize the data sets, monitor exceptions to established thresholds and unusual trading situations, measure trading volume and velocity, and draw correlations among stock and data elements—all in real time.

For instance, a blue pulsing activity meter is displayed in the virtual environment to indicate the aggregate trading activity at each trading post panel on the actual floor. Also, when a predetermined threshold—such as a price change, volume, or velocity—is exceeded for a particular stock or group of stocks, the cap on top of the post panel will pop up, indicating that attention is warranted.

"We can see where our busy stocks are, where there might be

The 3D trading floor consolidates data streams from numerous sources into one graphical model that uses color, 3D images, geometric shapes, and animation to display data. To acquire more specific information about an event or stock, users can view a bank of computer screens and "drill down" into the data.



Images © 1999 New York Stock Exchange

NYSE officials can fly through the virtual landscape, which includes 3D representations of trading posts and real-time video.

some hot news out on stocks, and where trading thresholds have been exceeded," Allen says. "The amount of information you can display and process in 3D is extraordinary."

A Virtual Move

The concept of using real-time 3D data in a virtual representation of the NYSE's trading floor stems from a 1994 meeting between the Exchange and one of its listed clients, SGI (Mountain View, CA), which provided the NYSE with an overview of its technology. "When we saw some of the things they could do with their technology, I instantly raised my hand and said, 'I think there is something we can do with this that is a perfect fit.' So out of a simple meeting we spawned this effort," Allen says. And it has resulted in the first large-scale virtual environment for business applications.

As the world's leading equities market, the NYSE handles over 800 million shares in trading activity a day. During the last nine years, trading volume has quadrupled from 42 billion shares in 1989 to 170 billion last year. "The increase in listed companies, volume, and velocity of trades has produced a tremendous amount of data. As our systems architecture and trading environment became more complex, we were looking for ways to convert the data into information we could readily use and manage," explains Allen.

Users can zoom in on any area of the virtual trading floor, including the information surfaces within the model, to monitor activity in real time.

Alas, the NYSE has been ready for this 3D transformation for some time, but all the necessary technologies needed to make it a reality—visualization technology, data warehousing, and data mining techniques—were still evolving. The biggest hurdle, however, was the dearth of development tools, which forced the group to abandon its first attempt at going virtual and take up the cause again a few years later.

The second initiative began to gel about two years ago, with the Securities Industry Automation Corp. (SIAC), the NYSE's data processing branch, acting as the technical project manager for creation and development of the real-time 3D trading floor model and software applications. Among SIAC's more crucial decisions in the early development stage, says Allen, was to hire an architect (Asymptote Architecture of New York) to design the virtual environment and the associated physical space.

"We needed a model that would enable us to easily understand the spatial relationships and animations that link and convey our data information," Allen says. "We also required the ability to navigate the virtual trading floor quickly and efficiently."

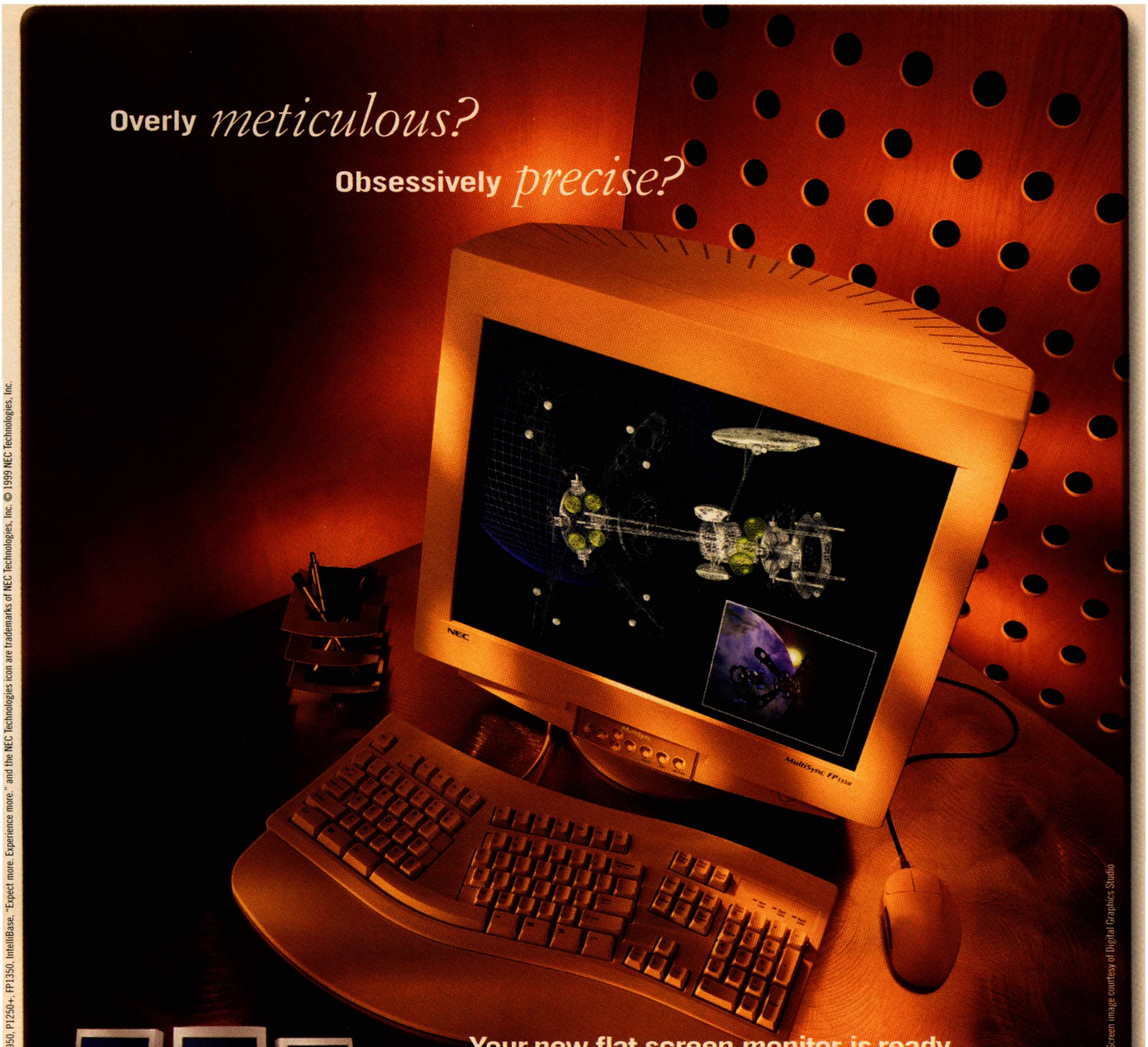
According to Allen, the design phase of the project, as expected, was quite lengthy. Once you move past the 2D world, she says, you have a whole new set of variables—color, form, space, time, iconography, and placement. To construct this new environment, SIAC used SGI's Iris Performer tool set and scripted the application code. Real Time-Synthesized Entertainment Technology (RT-SET), a Shefayim, Israel, designer of virtual newsroom sets, wrote special code for the 3D graphics and animations.

All this proprietary software runs on five SGI Onyx2s, which are used to drive the overall solution, while an Onyx2 Reality is used for application and content development.

A New Dimension

The 3D imagery appears on high-resolution flat-panel screens arranged in a three-by-three formation, including three monitors the operations staff uses to "drill down" into data to

The GUI for the 3D system is centrally located between actual trading rooms for accessibility to a wide range of users.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The 3D model alerts operations staff to unusual business and systems activity, enabling personnel to pinpoint where complex events are taking place.

find more detailed visual and analytic information. Simultaneously, the entire 3D trading floor representation remains on the upper six screens for ongoing monitoring. "We're able to see quite clearly what's happening as a whole and in particular locations, whereas before, we'd have to interrogate five or six databases, and then process that information," Allen says. "With the 3D trading floor, we capture all the trading operations information produced by the Exchange in a single place."

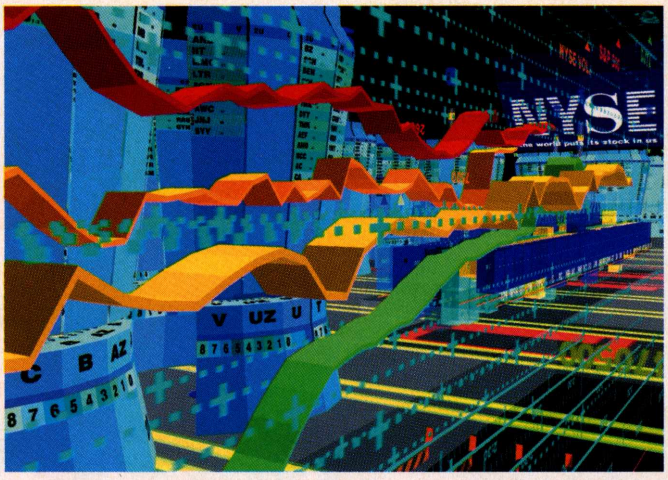
According to Allen, one of the project challenges was prioritizing the virtual model's functions so the Exchange could get the virtual trading floor up and running, which occurred this past spring. "We have a list a mile long of things we want the model to do—and we know it can do all those things—but we had to narrow down the scope so we could make it a reality," she says.

Nonetheless, during the first two months of operation, the staff had been planning enhancements to the 3D model, "adding capabilities that people just can't do themselves," Allen says. These include wide-scale data correlations between systems events and business activities.

For instance, if there is an unusual trading activity in a group of stocks with certain common categories (such as country or industry), the system will graphically display the correlations among them. "We don't even have to know if something is wrong; the system automatically alerts us," she adds, and then the floor operations group can evaluate the situation and respond accordingly. "The goal is to get the information processed quickly and smoothly. Because the markets move so fast, timeliness is extremely critical to our operations."

Currently, a core group of 15 operations employees uses the 3D trading floor regularly, while about 50 supervisors from the actual trading floor and their employees use the virtual data, albeit less frequently. "Since we've kept the usability piece of it simple, anyone can learn to use it," says Allen, and eventually, the model will be accessible to additional users.

The area where the model resides, known as the Ramp, is situated between two of the four Exchange trading rooms. Asymptote redesigned the 4- by 6-foot physical space housing the virtual environment to create a high-tech work space for operations control that includes glass walls, steel counters, and an electronic ticker and orbiting message board in the ceiling. The area's visibility on the floor, Allen notes, has sparked interest among the NYSE trading community.



The NYSE's Three-Dimensional Trading Floor application is the first large-scale virtual-reality environment for business applications.

Taking Stock in the Future

While the NYSE's step into the 3D world was a quantum leap, it is just the first of what may be many steps. According to Allen, the virtual setup was designed so that other applications and functions can be added easily. "This technology is so far advanced, there isn't anything like it in this business. We can process millions and millions of pieces of data in a single spot," she says. "But the power that we've seen with this technology is such that there are new applications being thought of every day. People in every sector are beginning to think in a 3D world. When they walk through the area and see the virtual model, they all have ideas for future applications."

One application to be introduced soon will be tailored thresholds, so thresholds can be determined by individual stocks, rather than by stock categories. Other future endeavors include making pieces of the virtual model available on the NYSE's Web site and in other locations within the NYSE, not just in a centralized area. The group may also prototype the environment to create a virtual set for broadcasting and NYSE promotional activities. In addition, the model will take on a new look in the year 2000, when the NYSE opens a new trading room.

"The initial goal was to use this technology to manage operations data. Now we're looking at business applications beyond operations monitoring," says Allen.

Karen Moltenbrey is an associate editor of Computer Graphics World.

Old Penn Station, by David Beker (3D Studio MAX)

Real or REALimage®?

Artist David Beker used 3D Studio MAX to create this incredible, photo-realistic scene. Like other CG artists and designers, David is constantly pushing the limits of technology to produce images that make it difficult to distinguish between what's real and what's rendered.

"I wanted to recreate Penn Station in 3D so people could experience that incredible space. I wanted people to be able to move through it and appreciate what it must have been like to be there. No other medium could come closer to recreating that feeling."

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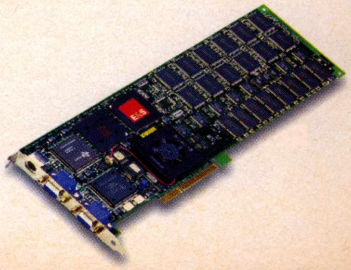

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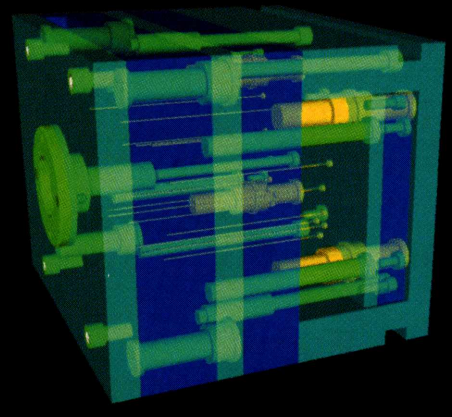


SOFTWARE THAT LEVERAGES CORPORATE KNOW-HOW AIMS TO REDEFINE PRODUCT DESIGN

BY JEFFREY ROWE

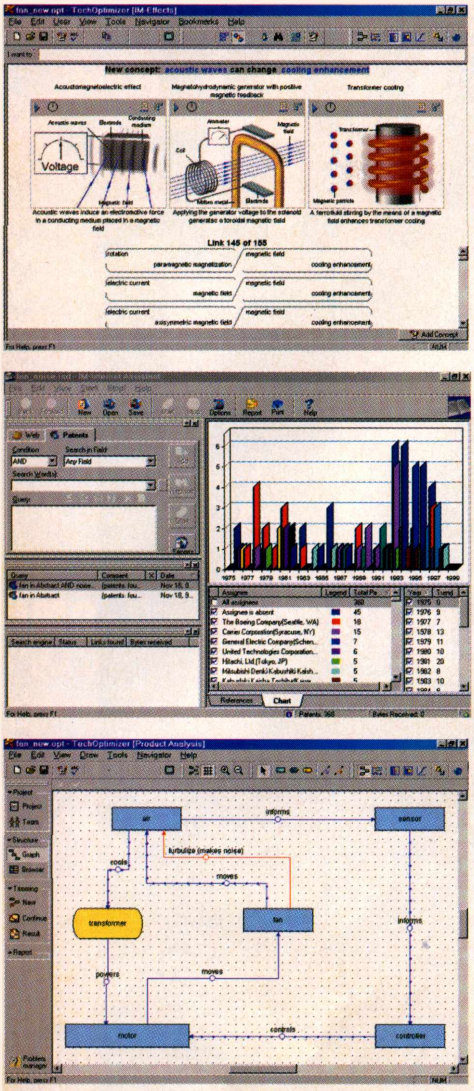
SDRC's VGX Moldbase Design creates "smart" models by constraining selected features. If plates are made thicker on this joystick mold, for example, ejector lengths adjust accordingly.

Ask a dozen CAD vendors to define design intelligence and you're likely to get as many different responses. While one calls it knowledge-based engineering, others define it as design optimization, front-end analysis, predictive engineering, or behavioral modeling. Yet, whatever it's called, design intelligence is showing up in an increasing number of CAD products in both the mid-range and high end and, as a result, is greatly influencing product-design methodologies and model behavior. Moreover, though the packages that add intelligence to the design process vary widely, they share the same goals—simplify product design, slash time to market, and cut development costs.

Because design intelligence is such a burgeoning technology—with new vendors continuously entering the fray—what follows is a representative, though by no means exhaustive, sampling of CAD packages that contain some of the most innovative design intelligence technologies on the market.

Technical Brainstorming

One vendor that is perhaps most readily associated with design intelligence is Invention Machine Corp. (IMC). The company



To aid designers in brainstorming, IMC's TechOptimizer displays relevant scientific laws (top), searches databases for related patents (middle), and analyzes products to define flaws (bottom).

offers a system of integrated software and an expert knowledge base designed to improve product and process development. IMC's products automate problem definitions and capture and disseminate knowledge to support what it terms the "technical creative process."

IMC's flagship product, TechOptimizer 3.0, is a suite of tools originally designed for use by researchers, although it fits into product design/development environments as well. In essence, it helps users define marketing or manufacturing problems and generates concepts for everything from creating innovative products to solving complex engineering challenges.

In addition to analyzing products and processes, TechOptimizer facilitates technical brainstorming by reviewing relevant scientific and engineering effects, such as gravity and galvanism, from a database of more than 4,000 effects, and showing them in action with animated diagrams. The software also searches its database of more than 2.5 million patents from various engineering disciplines and produces solutions by applying the most appropriate principles for a given problem. Moreover, it searches the Internet and the US Patent Office database for specific examples, effects, or particular scientific information that relates to specific design problems.

IMC must be doing something right, because Dassault Systemes recently made a $6 million investment in the company. The two firms already share a number of common customers, including Honda, who are looking to IMC and Dassault to introduce new knowledge-based innovation products. Honda's digital manufacturing strategy, says Kobayashi San, executive chief engineer of Honda research and development technology, is based on "a unified integrated architecture with Catia and is expanding to address knowledge management and innovation support tools around a future integration of Catia and TechOptimizer."

Dassault will be incorporating features of IMC's technologies into future releases of Catia to complement the company's Knowledgeware technology, described below. The two companies will work to provide software tools that leverage knowledge from multiple disciplines to generate innovative concepts. These knowledge-based innovation applications will become an integral part of a new generation of virtual product development, providing a process for creating innovative, cost-conscious products and optimizing the product lifecycle.

Knowledge-Driven Design

Dassault Systemes' Catia Version 5 models products, processes, and resources using a technology called Knowledgeware to support a knowledge-driven design methodology. Produced by the Catia development team, the software collects and reuses intellectual capital while allowing designers to explore design alternatives.

Knowledgeware captures corporate design and manufacturing know-how to automate design generation. To assist designers in product optimization, it correlates product definitions with "rules" and "checks." While rules are defined as a list of actions to be performed in a specific context, checks are relations that can be verified automatically or on demand to identify design violations. Users can build rules, which are visible within Catia's design tree, and embed them in a product model to maintain design intent.

The program also helps users make decisions by simulating design alternatives and their associated consequences. Adhering to previously established design limits, Knowledgeware conducts "what-if" analyses to determine the impact of a parameter modification. It also performs "how-to" analyses and displays all the possible parameters that can be changed to influence a given design. These two methods, "how-to" and "what-if," can accelerate the exploration of alternatives and help developers find optimal designs.

Historically, the progression of knowledge-based engineering has been slowed by high cost and skill requirements, resulting in a user base that seems limited considering the technology's potential. Catia V5 addresses this problem by integrating Knowledgeware at the core of the Catia architecture to drive a design—rather than gluing features on top of an application. As a result, rules and checks are handled by the software as objects, as are all other design features and specifications. That way, rules and checks can be copied and pasted from one design to another to facilitate the sharing of knowledge. This level of integration allows Knowledgeware to become part of the product-creation processes and methodologies in a more streamlined manner, compared to CAD and knowledge-based engineering products that are not as fully integrated.

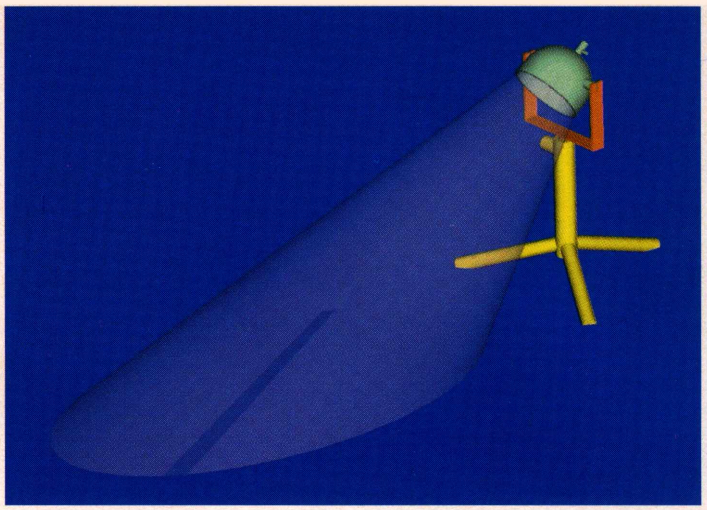
In the future, Knowledgeware technology will be incorporated in a growing number of Catia applications, from design analysis to manufacturing, so that corporate knowledge can benefit the entire product-creation process.

Behavioral Modeling

Parametric Technology Corp. (PTC) believes that the addition of design intelligence—in the form of behavioral modeling—is the latest step in the evolution of digital design that began with 2D

CAD and progressed to 3D CAD, solid and surface modeling, and feature-based parametric modeling. PTC's new behavioral modeling capabilities are embedded into the modeling kernel of Pro/E 2000i, the company's latest addition to the Pro/Engineer product line. (See "CAD on Its Best Behavior," August 1999, pg. 36.) The software's objectives are threefold: it allows the creation of so-called "smart models," it provides objective-driven design solving functions, and it enables open design environment.

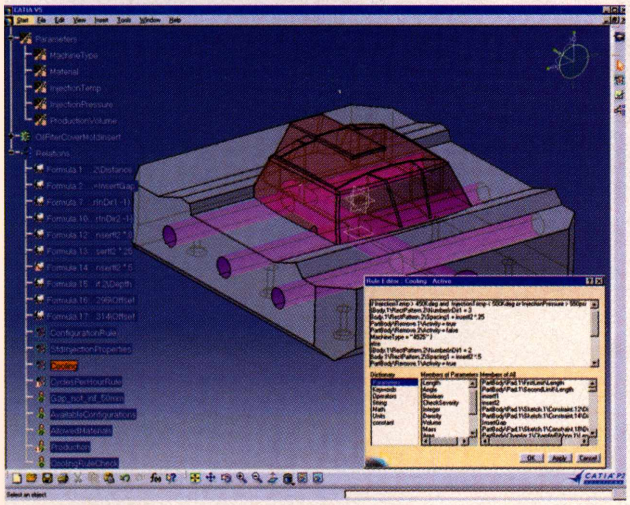
First, PTC's smart models are created using modeling techniques that capture geometry, specifications, design intent, and process knowledge. The company contends that the smart models are "intelligent" designs because they contain the specification and process information they need to adapt to their environment and because they are "aware" of their context and purpose. Since the models contain the key characteristics of a product, developers are freed from managing these aspects of a design to concentrate on enhancing their products.



The behavioral modeler in PTC's Pro/E 2000i software helps optimize designs with complex criteria. For example, given bulb location, light cover diameter, and the angle between the cover and base, the solver specifies a light cover design that will illuminate a specified floor area.

This approach of creating smart models goes beyond feature-based modeling because it incorporates adaptive process features, which permit a product to evolve within a given design environment. There are two categories of adaptive process features: application features that describe process information (for example, a pocket feature with the NC information necessary to mill it) and behavioral features that define the way parts in an assembly interact and that describe engineering and functional specifications (for example, mass properties, spatial allocation information, and angles of reflection).

The second aspect of PTC's behavioral-modeling process entails objective-driven design solving functions, which help determine optimized solutions in designs with complex variables, constraints, and criteria. This technology helps ensure that requirements are met and that the effects of change on product performance can be assessed. It can also resolve conflicting objectives—a tall order when using conventional approaches. Since the specifications are captured and defined within the smart model, the designer no longer needs to make small, iterative changes to transform an initial design into a form that better meets pre-defined specifications. Instead, the specifications can be used to drive the design.



Using Knowledgeware, in Dassault Systemes' Catia V5 software, Husqvarna created this engine by capturing company expertise and building "rules" that freed developers to explore "what-if" alternatives while adhering to design specifications.

The third leg of PTC's behavioral modeling triad is an open design environment for the bi-directional integration of supplemental software tools, information, and processes already used within a design organization. These additional resources can contribute to the process of solving for design objectives and can return results that become part of the final design. External resources and features also make a design solution extensible, because these can reside within the smart models as well as link to other software applications.

Capturing Design Intent

Because products have a design lifecycle—conception, initial engineering, final tweaking, and, often, late-cycle design revisions—and because the design often serves as the basis for derivative products, SDRC believes the best approach to product design is to build "design intent" into product models. The company's variational geometry-based VGX technology achieves this by capturing design intent in the constraints that define the product. As a product is modeled, constraints are applied at the wireframe, part, and assembly levels. These networks of constraints are solved simultaneously to drive the resulting geometry.

In the initial design stage, when flexibility is important, VGX sketching and part-modification tools let designers constrain only the aspects of a design for which a constraint is meaningful. The design intent is captured, but the rest of the design remains flexible. As the product begins to take shape, VGX constraints allow assemblies to be constructed so that each piece intelligently relates to its neighbors. If a part is modified, these relationships ensure that the assembly continues to represent the intent of the designer that put it together.

SDRC's focus on design intent continues with the recent release of VGX Moldbase Design. This module takes the concept a step further with intelligent features that "understand" the con-

There's always one.

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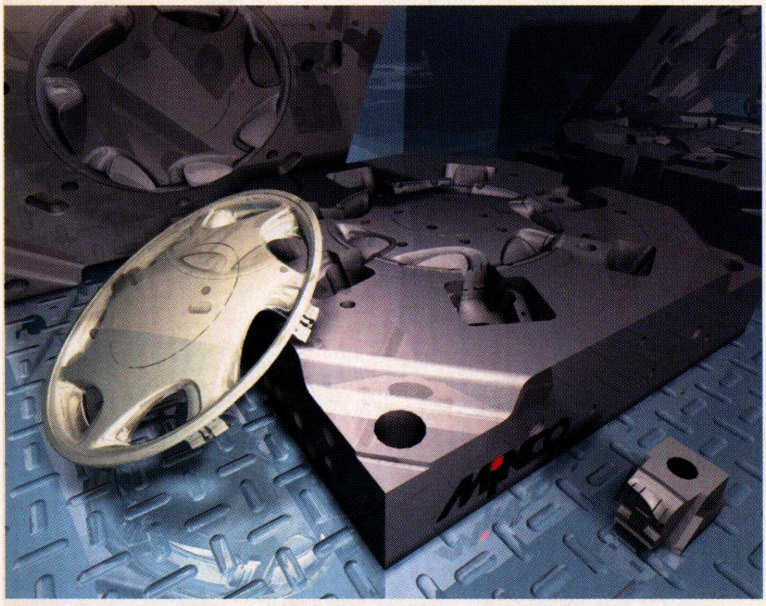
text of a product feature before it is built. Moldbase designers can include features such as cooling lines and guided ejectors in their models, and VGX Moldbase will automatically include the critical design intent for them. This kind of intelligence handles changes in the moldbase configurations, changing lengths and maintaining critical clearances, as required.

Predictive Engineering

MoldWizard, for automating mold tooling design, is the first in a series of "Process Wizards" that Unigraphics Solutions has released for the Unigraphics CAD/CAM/CAE product line. In fact, Version 16 of Unigraphics is based largely on the notion of capturing engineering know-how and incorporating it into the design process a concept the company calls Predictive Engineering.



Minco Tool & Mold created the basic design of this complex hubcap mold in just four hours, as opposed to 30 hours using previous methods, with Unigraphics' MoldWizard, a knowledge-based mold-design environment.

MoldWizard, an automated and associative environment integrated with Unigraphics software, captures expert knowledge to enhance the productivity of injection mold designers and manufacturers. It is an environment of component data and functions organized to facilitate workflow through the mold-design cycle.

MoldWizard was developed with input from mold designers to automate mold core and cavity design and parting surface generation. As a mold design evolves, the associativity provided by Unigraphics' architecture automatically reflects changes to all relevant parts of a design. For example, changes made to a part model are propagated to the core and cavity. Similarly, changes to an insert box, plates, or standard components of the mold assembly are reflected in the moldbase. Mold shops can also receive CAD data designed on different systems and can maintain associativity with imported models using MoldWizard.

Component Modeling

Bentley Systems Inc. considers Engineering Component Modeling, a central feature of its Java-based MicroStation/J, to be the key to intelligent design because it automatically derives design modifications and representations. This philosophy is analogous to the way spreadsheets are created and used. With spreadsheets, you build mathematical models by specifying relationships between numbers or values. If a parameter in the spreadsheet is changed, the entire model automatically updates, including derived representations, such as graphs, charts, and tables.

MicroStation/J lets you build intelligent engineering models in a manner similar to spreadsheets, although there are differences between engineering components and graphic elements. One major difference is that engineering components can have rules specified for geometry based on design parameters. Components can have relationships with other components, so that when one changes, others are updated. For example, if a flange component is created, then resized, the flange diameter and number of holes changes as well.

Another big difference is that engineering components can have different geometric representations. For example, an engine part might have a detailed 3D representation in a rendered view and a 2D schematic representation in an engineering drawing. These multiple representations can improve productivity, because various representations of the same engineering model are automatically updated and generated when a design change is made.

Design intelligence is largely in the eye of the beholder—or should we say, the vendor. Still, while all the design-intelligence packages purport to provide solutions to problems, the better ones first help you define the design problems before attempting to solve them. And, of course, some packages will likely fit your company's workstyle better than others. In each case, however, the distinct advantage of design-intelligence software is that it provides a means of leveraging a company's most valuable asset—its existing intellectual capital—to help developers create more innovative products as well as a means of getting them to market as quickly as possible.

Jeffrey Rowe is the principal of Cairowest Group, llc, an independent design consulting firm in Salida, Colorado. He can be reached at jrowe@cairowest.com.

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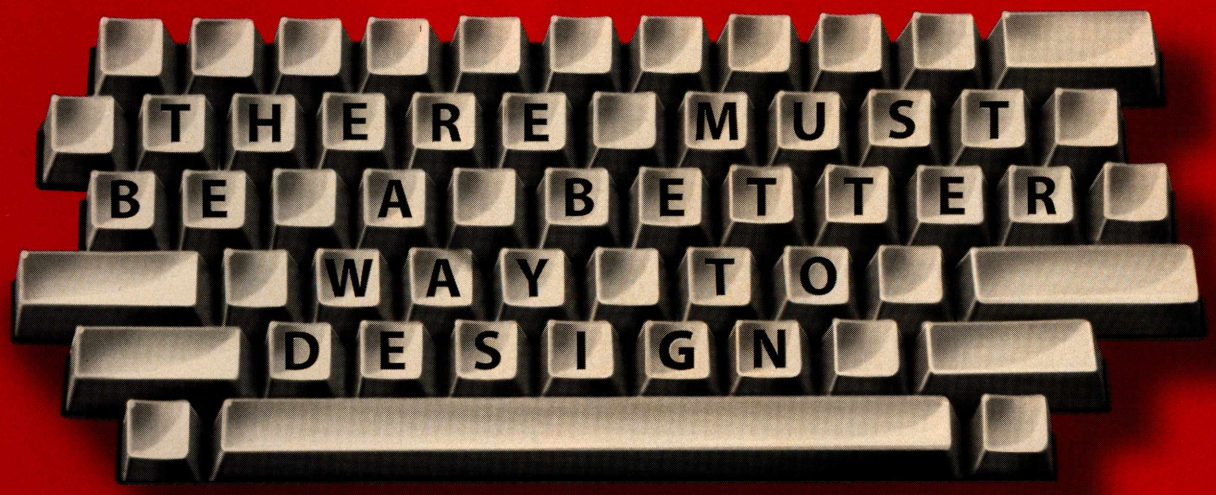

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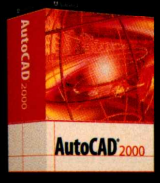

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ANIMATORS WORK OUT THE BUGS TO PRODUCE A DAILY ANIMATED TV SERIES

REAL TROOPERS

BY KAREN MOLTENBREY

It takes a special breed of adventurer to rescue scientists from enormous menacing bugs on distant planets. It also takes a talented group of artists to create the 3D animation that will enable the young band of digital soldiers to perform these heroic deeds. But the animators at Foundation Imaging (Valencia, CA) are proving they are up to the task, as they join forces with digital-content creators from other animation studios to produce 40 episodes for *Roughnecks: Starship Troopers Chronicles*, an all-CG children's television series broadcast daily on the national Bohbot Kids Network (BKN).

Set in the not-so-distant future, *Roughnecks,* based on the book and the 1998 feature-film *Starship Troopers,* chronicles the ongoing adventures of four main Starship Troopers who mobilize to fight the First Interstellar War against huge and deadly alien bugs.

"They have different missions each week. In the first couple of shows, they must rescue scientists on remote outposts—and they kill a lot of bad bugs in the process," says Jeff Scheetz, animation producer at Foundation Imaging. The soldiers, known as Razak's Roughnecks, battle the invading insects for five episodes before blasting off to a different planet. This story line not only provides new backdrops, but also introduces new deadly bugs. By the end of the season, the Troopers—and animators—likely will have encountered at least 40 races of human-size pests.

Originally scheduled as a 2D show by producer Tristar Children's Television (a Sony Pictures Entertainment company), *Roughnecks* eventually evolved into a 3D series that required far more work than originally planned.

Getting "Bugged" Down

When the show first aired in September, Foundation Imaging, which was collaborating with Flat Earth Productions (Burbank, CA), had completed several episodes. For the most part, Foundation Imaging created the human characters, while Flat Earth made the bugs, and both divvied up the exotic spaceships and vivid, realistic landscapes. Not long after that, Flat Earth handed over its share of the work to Foundation Imaging and other animation facilities. "The new studios that come aboard can use the basic objects we created for the first few shows and will only have to create

objects specific to their episodes," says Scheetz.

For the models, Sony provided the groups with 2D designs and color references, from which the animators built 3D objects using NewTek's (San Antonio, TX) LightWave modeling software and Adobe Systems' (San Jose, CA) Photoshop texturing tool on in-house-built NT workstations. "In some cases, we create objects that match the style and theme set by Sony. In other cases, Sony gives us architectural-like floor plans of how the entire scene and action should be laid out," Scheetz explains.

"The process is more comparable to live-action filmmaking than the way cartoons are made," he notes. "It's not just a matter of painting a background and then putting foreground action in front of it. Every time you open a new scene, you are starting with an empty sound stage and populating it."

By using LightWave, the animators have been able to come up with what Scheetz calls "hacks," or clever workarounds to accomplish feats that ordinarily cannot be done with the software. "Just the way the Troopers' bodies function is the result of a large combination of hacks that give the characters a leading-edge look," he says.

In Version 6, NewTek has "integrated, elegantly, the things that we've been working hard to achieve through hacks," Scheetz says. These include the use of two plug-ins: Relativity, so characters' heads remain attached to their bodies, and Metamation to smooth it out.

By incorporating basic animation techniques typically used in feature films, the Roughnecks animators are achieving a cinematic, high-end look that is new to children's CG television.

One of the biggest modeling challenges has been the creation of the human characters, particularly their heads. "That's an area where additional research needs to be done in order to achieve more realism," Scheetz maintains. For example, "we are still creating characters with very short haircuts, but we'd like the opportunity to make female characters with long, flowing hair."

To animate the characters, the teams used motion-capture technology. For the first set of shows, Foundation Imaging used Ascension Technologies' (Burlington, VT) Flock of Birds mocap software, which the company plans to use in conjunction with Vicon Motion Systems' (Tustin, CA) Vicon 8 optical motion-capture system. The group is also employing Kaydara's (Montreal) Filmbox real-time production system to process and filter the high-volume mocap data (to smooth the motions and seamlessly blend movements) before exporting it into LightWave.

According to Scheetz, the animators are capturing complicated motion for several hundred shots per episode, including complex combat maneuvers and physical stunt work that would have been extremely difficult to hand animate. "The speed and efficiency of motion capture is absolutely necessary for us to get through 40 episodes," he notes. "I'm sure the artists here would rather be doing keyframe animation. But when you have five soldiers in space armor storming up a hill to chase down some bugs, you can either do that with a 20-minute mocap session so the shot can be finished by the end of the day, or you can spend three weeks animating each character by hand."

In addition to its speed, motion-capture animation is far more realistic than hand-keyed movement. "There are shows, such as cartoons, where the exaggerated animation is part of the art form. But in terms of action-adventure shows, the closer you can get to realism, the better," Scheetz notes.

The team does, however, use LightWave's Morph Gizmo to keyframe all the facial animation, while the lip sync is accomplished using a range of techniques, depending on the artist's preference.

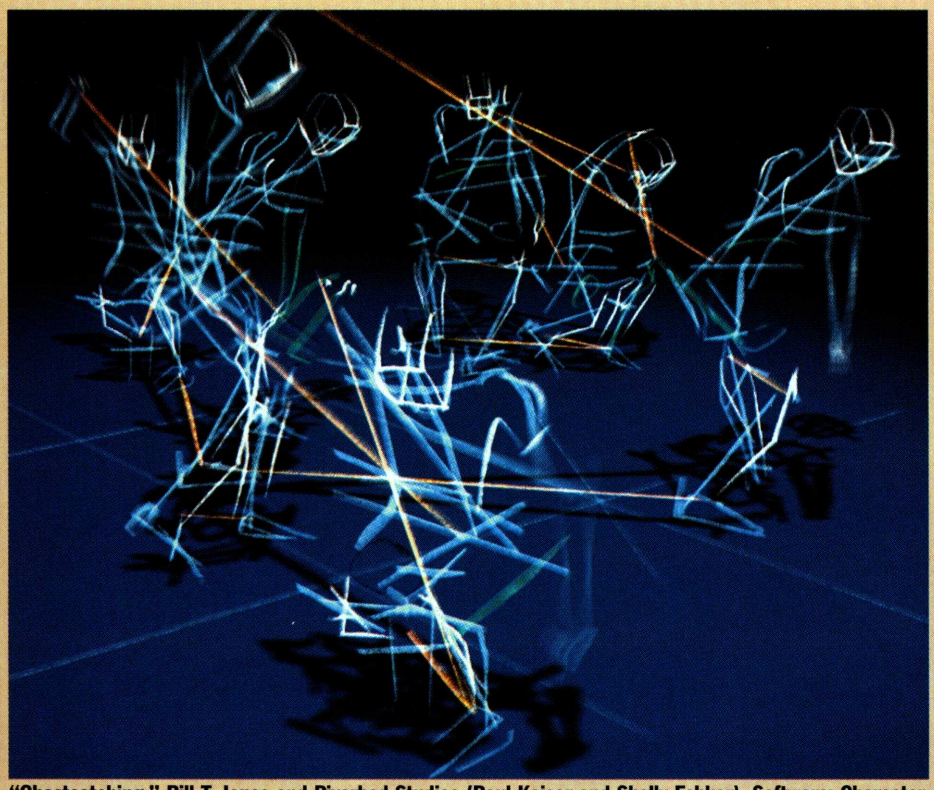
With an eye to the future—specifically, high-definition television (HDTV)—the animation teams are constructing the shots without the need for compositing, so if the series needs to be rendered for HDTV, no re-compositing work will be required.

While most CGI television shows for kids are visually simplistic, the *Roughnecks* animators are trying to break the mold. "We're using LightWave 3D's HyperVoxel rendering technology to create realistic explosions, bug splats, and so on. We're also using plug-ins to give the show more depth and visual style than any previous all-CG program," says Stephen Pugh, general manager of Foundation Imaging.

While pleased with the end result, Scheetz notes that the techniques require time-consuming rendering algorithms. "It takes about five times longer, but it's worth it." The result is a new, stylized, cinematic look. "What we're doing has yet to be done on children's weekly—let alone daily—television," he says. This includes basic techniques such as motion blur, depth of field, adding a film-grain look, and using image-processing filters, such as light diffusion, to take the edge off the high-tech CGI look.

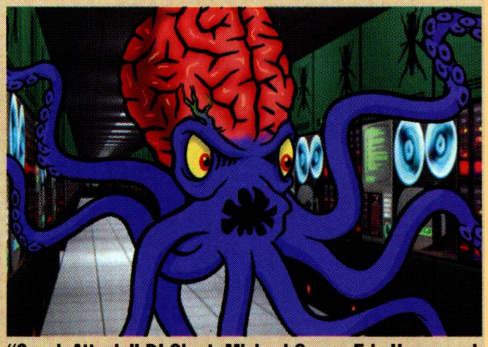
Adds Ron Thornton, Foundation Imaging president: "A television series of this scope and complexity has never before been produced. We're pushing the envelope to do this show properly, in a fiscally prudent manner."

Karen Moltenbrey is an associate editor for Computer Graphics World.



"Ghostcatching," Bill T. Jones and Riverbed Studios (Paul Kaiser and Shelly Eshkar). Software: Character Studio and 3D Studio Max.

"Colourize," Colour Movie (Michelle Hammond and Brandon Martinez). Software: Photoshop, After Effects.



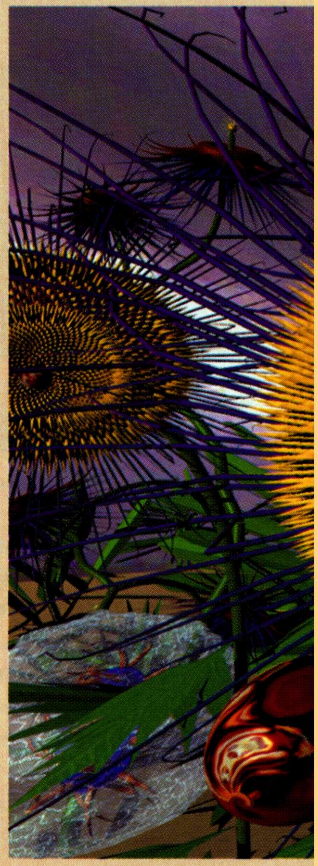
"Sneak Attack," DJ Qbert, Michael Garon, Eric Henry, and Doug Cunningham. Software: Photoshop, After Effects.

Digital Film Fest

Digital cinema has come of age, especially with the success of last year's feature-length foreign film *Festen*, shot entirely in digital video, and the announcement from George Lucas that the new *Star Wars* film would be digitally projected. So it's no small wonder that D.Film's traveling Digital Film Festival was featured at this year's Cannes Film Festival MITIC (International Market for Film Techniques and Innovation) pavilion, which touted the theme "Digital Cinema."

D.Film, an on-line and traveling showcase of films made with low-cost digital tools, promotes digital filmmaking by inspiring its audience to not only make their own films using desktop technology, but also to share the projects with their peers via the Internet (www.dfilm.com). This year's D.Film traveling festival contains a vast array of digital work, from digital video to full-CG design and animation, selected from more than 1000 entries. These include works from traditional directors using digital video, films by graphic designers, and work from modern dancers, comic-book artists, and even a hip-hop DJ, all in a 60-minute presentation of digitally produced shorts. Among the highlights were: "Ghostcatching," featuring dancers created from motion capture pulled from photographs of dancer Bill T. Jones; "Pellucid Spaces," showing artificial-life programs that create "characters" in front of a virtual camera; and "Millennium Bug," a surrealist's peek at the future of urban sprawl.

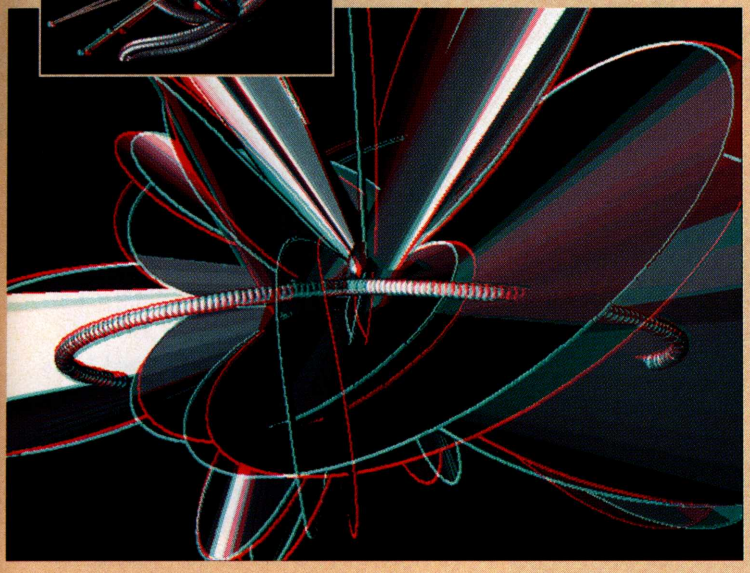
Besides its stop at Cannes, the festival is traveling to more than 20 cities worldwide, including Seattle. A small sampling of images from the show appears on the following pages. —*Katherine Tyrka*



"Pellucid Spaces," Jon McCormick/Odyssey Productions. Software: Proprietary.

FOLIO

"Azimuth," Staceyjoy Elkin and Mark Hofschneider. Software: Shareware originated by mathematicians to plot algorithms.



"Millennium Bug," Lee Lanier/PDI. Software: Photoshop, After Effects, PowerAnimator.

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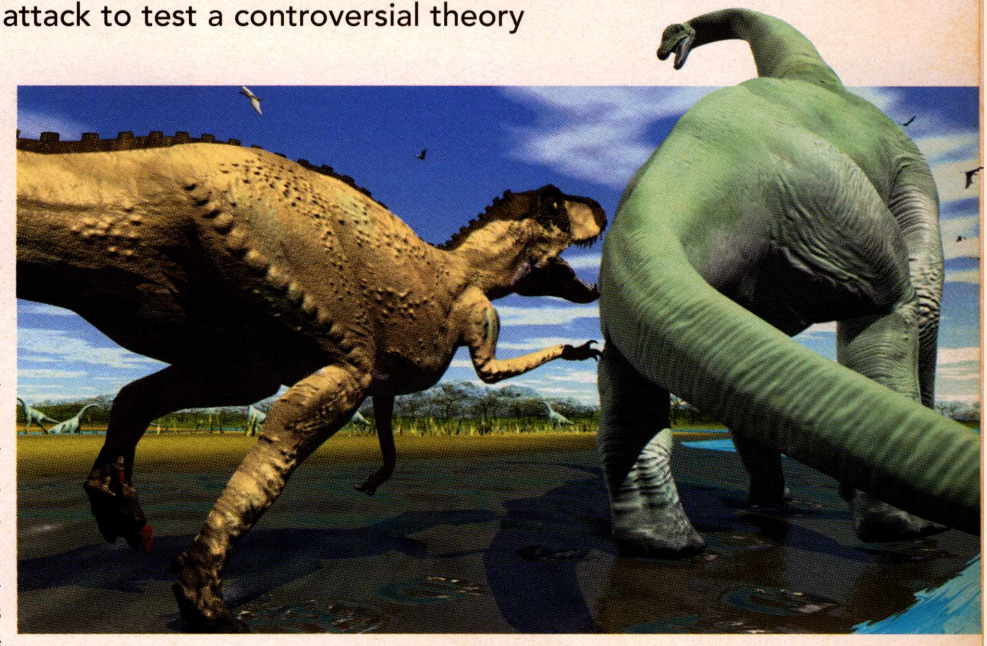
SIMULATION

RETRACING PREHISTORIC FOOTSTEPS

Animators simulate a dinosaur attack to test a controversial theory

BY KAREN MOLTENBREY



With help from paleontologists, animators re-created a theorized dinosaur attack, using a trackway of fossilized footprints as a guide for choreographing the chase.

When animators at Pixel Kitchen were hired to complete eight minutes of computer animation for a Discovery Channel broadcast, they had to retrace some colossal steps. Using 3D computer graphics, the artists simulated a hypothesized dinosaur attack based on fossilized footprints and analyses from paleontologists to determine whether a relatively small but ferocious carnivore had stalked and attacked a much larger prey—a behavior previously ruled out for the species.

"The program *Dinosaur Attack!* re-creates a 100 million-year-old scene based on analyses of the evidence by scientists and artists," says Dan Seely, animator and founder of Pixel Kitchen, a Boulder, Colorado, 3D design and animation company.

The documentary, which aired in September, explores the work of paleontologist Roland Byrd, who 60 years ago discovered two sets of fossilized dinosaur tracks from the Cretaceous period in the Paluxy River Valley in Glen Rose, Texas. After conducting extensive studies, Byrd theorized that the tracks were made during an attack by a nine-ton carnivorous T-Rex relative on a 30-ton brachiosaur-like herbivore, an observation that still generates controversy within the scientific community.

When the issue resurfaced recently, Discovery Channel and the UK's Channel 5 network decided to explore the theory. "They wanted us to create a simulation and animate the evidence to determine if this theory was possible," Seely says.

A CG Investigation

To help the animators in their "forensic investigation," the producers assembled a team of paleontologists and other experts to assist in the extensive research needed to make the simulation as realistic as possible. An expert on fossilized footprints confirmed the dinosaur's type, size, stride, speed, and other information relative to each set of tracks, while a sculptor specializing in dinosaur re-creations from fossilized remains provided an actual model of the predatory acrocanthosaur. Both researchers provided diagrams and analyses of the trackway to help the animators choreograph the attack.

After digesting all the information, the animators began modeling the creatures using NewTek's (San Antonio, TX) LightWave 3D on a variety of NT and Unix platforms, including SGI (Mountain View, CA) Octanes and NT-based 320 Visual Workstations. To create the acrocanthosaur, the artists began with a Viewpoint Digital (Orem, UT) model. But after discussions with various paleontologists revealed the model to be an inaccurate representation of this particular dinosaur, the group abandoned the model and created the creature from scratch. The artists' 3D clip art brachiosaur model, however, was closer to its mark, but still required adjustments to the head, neck, and tail. For texturing, the artists used MetaCreations' (Carpinteria, CA) Painter to achieve the realistic folds and irregularities of the beasts' skin.

While the modeling and texturing needed to be accurate, the animation had to be even more precise. "To prove the theory, the [animated] dinosaurs had to hit the footprints [from the fossil casts] at each step," Seely says. The entire theory hinged on the smaller beast being able to close in on the larger animal so it could inflict bites and scratches while still being agile enough to avoid being struck by the prey's tail and legs. "The hope was that the combination of correctly constructed models and a to-scale footprint diagram, along with some key information about the dinosaurs' speed and length of stride, could be pulled together to help prove or disprove Byrd's theories," he explains.

To begin the process, the animators placed a scanned image of the trackway diagram under the feet of both creatures and color-coded it "so we could easily see each footprint in the environment and its correlation to a footprint made by the other dinosaur," Seely says. Based on information provided by the experts, the animators

knew that the prey had set the pace for the chase, which was estimated at 4.3 miles per hour. They also knew each dinosaur's mobility range and stride. "This all made the larger sauropod's steps easy to set," he adds.

Once the larger animal's walk was established, the artists used the color-coded diagram to place the predator on its marks, which was more difficult, says Seely, because its pace changed to avoid being struck by the prey's massive tail or trampled as it closed in for a strike. At one point in the actual trackway, there's a missing left footprint in the acrocanthosaur's sequence, which the experts suspect occurred when the predator leaped to strike. "This became the center point of our timing and choreography," says Seely.

To help re-create this run and hop, animator Jason Giles laid out soda cans in his backyard to represent the tracks, then tried to work out the timing and movement. Giles and the other animators also studied animals thought to have movements similar to the prey's (elephants) and the predator's (ostriches) in order to grasp the physics and balance involved.

The initial animation was then presented to a group of paleontologists for review. Afterward, the animators refined the choreography and tested the footstep cycle numerous times "to a point where we could say the simulation reinforced the theory or discounted it," Seely says. "Our analysis showed that if the missing footprint indicated a hop, the hop occurred at the right time to allow the predator to accelerate enough so that it could have bitten the prey—making the theorized chase a definite possibility."

No bones were found at the site, but the attack may still have been a success. Assuming the predator was able to bite and scratch its prey, scientists theorize that it could have caused blood poisoning that, after hours or days, eventually felled the larger beast. An analog in today's world would be the Komodo dragon, a large meat-eating lizard dating back from the Jurassic period whose bacteria-packed saliva is so lethal that its victims typically die from infection within days of being bitten.

Using Painter, the artists created six levels of textures to achieve the acrocanthosaur's tri-color appearance.

"It's miraculous that some experts in the field, even as far back as 60 years ago, could look at the footprints and make certain determinations, such as the timing of the chase, without the technology we had available to us to test out those theories," Seely notes.

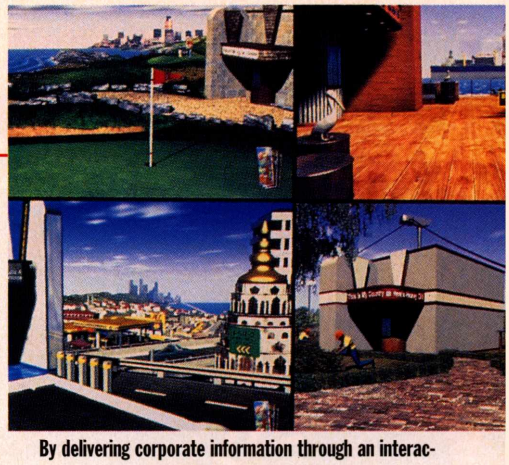
Key Tool **LightWave**, NewTek (www.newtek.com) infoNOW 60

BUSINESS

All Work and a Little Play

Gaming technology conveys a corporate plan

BY KAREN MOLTENBREY



By delivering corporate information through an interactive, game-like environment, Conoco believes it will help employees retain what they learn, and have fun, too.

When Conoco, an international energy company in Houston, wanted to educate its employees, potential customers, investors, heads of foreign countries, and others about its worldwide operations, it sent them to ConocoLand, a 3D world filled with fun, adventure, and corporate information. Admission to ConocoLand, an interactive CD-ROM for the PC, grants entry into five "lands" in a simulated amusement park setting, where visitors can, for example, take a virtual helicopter ride to a deep-water drilling ship, ride a tram through a production facility in Venezuela, and light up the London skyline, all the while learning about Conoco and its business dealings.

"Although interactive CD-ROMs are generally associated with games and entertainment, we wanted to harness the excitement of this medium to tell the Conoco story," says Teresa Wong, Conoco's project manager for new media. "From the beginning, the graphics really set this apart from anything else that we've done."

The two-hour tour of *ConocoLand* is guided by Conoco president and CEO Archie Dunham. A stop at each of the lands includes an introduction by Dunham, several interactive activities, and a visit to a movie theater with at least one film about the company's operations in that region. In Lone Star Land, for example, moviegoers can view "Big Business Texas Style," while in Latin Land, they can choose between "Here's Heavy Oil" and "This is My Coun-

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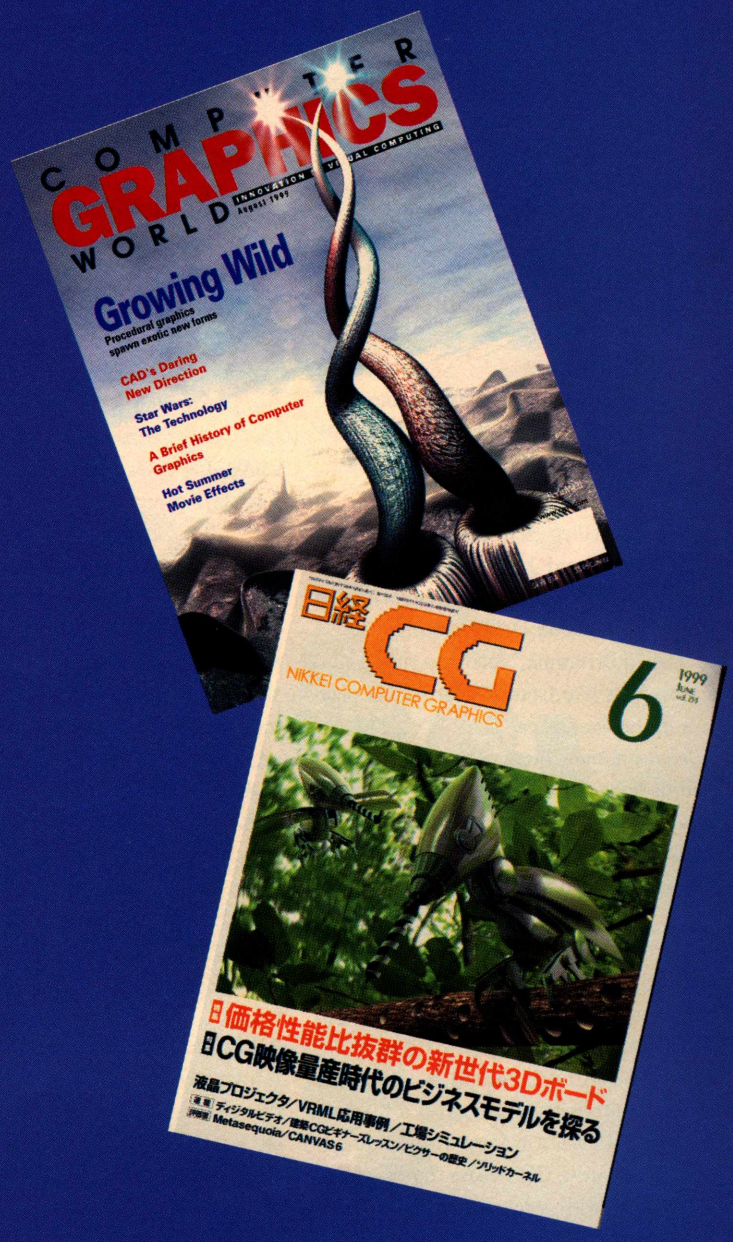


Nikkei Computer Graphics

Conoco president and CEO Archie Dunham was filmed against a bluescreen. His image was then inserted into the digital world, where he serves as a personal tour guide.

try." Additionally, each theater lobby features creative and humorous coming-attraction posters, with voice-over reviews of titles such as "Good Drill Hunting" and "A Fish Called Britannia," each describing specific projects like Conoco's Britannia platform in the North Sea.

"*ConocoLand*'s interactive features and 3D multimedia technology catapult our audiences to places they could otherwise only read about, and invite them to actively participate in these virtual worlds," says Wong.

Millennium Marketing

While unique, *ConocoLand* is not the company's first attempt at using a CD-ROM to disseminate corporate information. However, using colorful 3D graphics, interactivity, and multimedia, along with a humorous approach, was a far cry from its previously conservative CD release that used traditional text with a few images and video clips. "This time, we wanted to show people that we're a progressive company," says Wong. That's when Conoco sought out Engineering Animation, Inc. (EAI), an Ames, Iowa, communication and visualization company. Together they came up with the concept for *ConocoLand*.

The project's timing was also crucial: Conoco was undergoing a $4.4 billion initial public offering—the largest in US history—and wanted to use this tool to communicate its business strategies. "A wide range of people would be using the disk—from heads of states to college graduates seeking employment at the company," says Carol Jacobson, an EAI senior director. "So the presentation had to be fun and interesting for a diverse audience," including Conoco employees who had limited contact and knowledge about the company's dealings in Argentina, the UK, or other parts of the world.

"If you are going to ask people to spend a lot of time on their computer learning about Conoco, and you're competing with a million other things they have to do that day, you'd better present something that's innovative, interesting, and fun," says Wong.

Creating ConocoLand

ConocoLand is populated with 3D models created in Discreet's (Montreal) 3D Studio Max and VisModel, EAI's proprietary modeling software, running on an array of Unix-based PCs and SGI (Mountain View, CA) and Hewlett-Packard (Palo Alto, CA) workstations. To animate and render the objects, the artists again used Max, but for higher polygonal images, EAI's VizLab software was better suited for the task. Rendering was performed in Adobe Systems' (San Jose) Photoshop, while Max's particle system played a key role in creating the park's large water fountain.

To add a personal touch to the CD required a large commitment from CEO Dunham, who was filmed against a bluescreen acting out various scenes. The EAI artists then composited his video image, along with other film footage, into the CG using Adobe Systems' After Effects. "We were combining video with 3D animation, so Dunham had to look real while the fountain he was standing by was completely animated," Jacobson says.

Incorporating a large number of 3D objects, along with various multimedia and interactivity, proved particularly challenging, according to producer Destry Davison, especially when each land had to have its own look but blend naturally with the others.

To provide *ConocoLand*'s interactivity, the software engineers used EAI's proprietary Rise game engine, which was also used to develop the Disney interactive computer game *A Bug's Life*, also under way at EAI during the same time. However, to enable the animations to play within the Rise environment required the *ConocoLand* programmers to script some additional code.

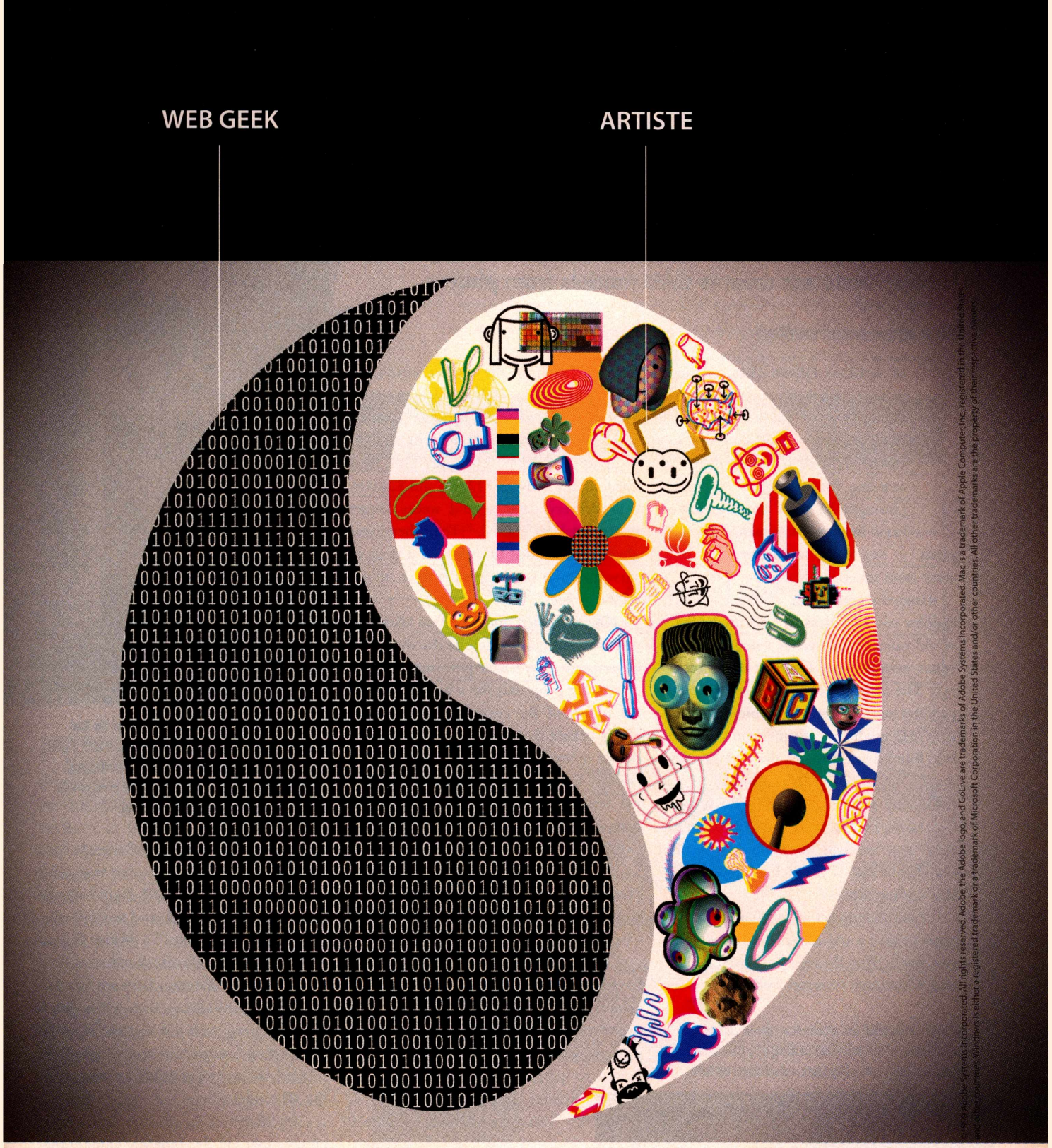
Since *ConocoLand* was completed several months ago, more than 7500 CD-ROMs have been distributed, "which is a lot for our industry, where the majority of our business is extremely targeted," Wong says. "And the feedback we've received has been tremendous."

Both Wong and Jacobson attribute the project's success to its use of leading-edge gaming and visualization technology to deliver corporate information. And it's something that Jacobson predicts will become even more popular as people are increasingly exposed to digital imagery through games and the Internet.

Using the *ConocoLand* map, visitors can easily make their way around each virtual "land" within the amusement park, where interactivity and 3D animations convey information about Conoco's worldwide business ventures.

"When we first started, we threw out all the rules," Wong says, "then we looked at how to best engage the users, which is key because the more engaged people are, the more apt they are to retain your message."

Key Tool **Rise**, Engineering Animation, Inc. (www.eai.com) **infoNOW 61**



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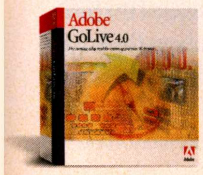

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COMPUTER-AIDED DESIGN

A Picture's Worth a Thousand Lines

How an architect creates CAD models from photos

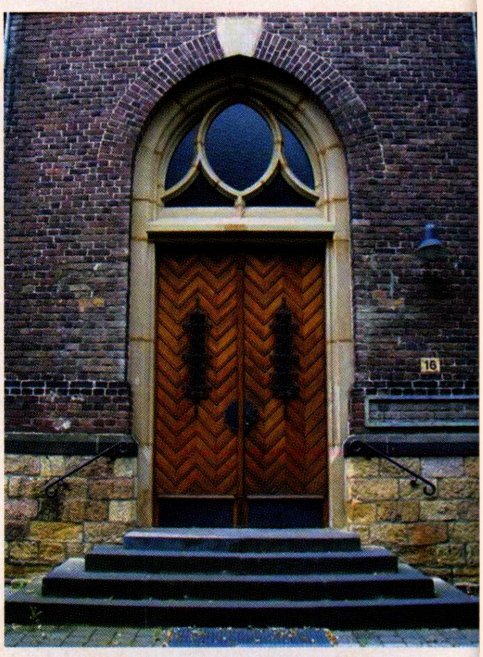
BY KAREN MOLTENBREY

For architect Olivier Hess, taking a picture has taken on new meaning. By using a 3D modeling package that quickly and inexpensively creates an accurate 3D CAD image of a building from an array of digital photographs, Hess' small architectural firm in Membach, East Belgium, is beginning to lure project bids away from much larger competitors.

Hess discovered the software—which enables users to measure and model real-world objects and scenes using photos—when searching the Internet about a year ago. The architect experimented with the product before submitting a bid to create a 3D CAD model of a former monastery in Bad Muenster, Germany. Because Eos Systems' (Vancouver, British Columbia) PhotoModeler requires practically no surveying, Hess' low bid and short turnaround time won his firm the contract—despite the skepticism of the person supervising the bidding process.

"I bid the project at $4000 and told the agency that I could deliver the 3D model in two weeks from the time I received the go-ahead," he says. "Several weeks later, I received a call from the project supervisor, who questioned my ability to deliver a quality product at that price and time frame, but said that because of the bidding rules, I was going to get the job." The other bids, Hess was told, fell between $12,000 and $24,000, with delivery dates several weeks longer than what Hess quoted. "[The others] had obviously intended to bring out a team of surveyors who would spend a week or two on the project."

Hess stumbled upon the Bad Muenster construction plans when he discovered an advertisement by a local government agency seeking proposals for a highly detailed 3D model of the complicated centuries-old structure that was needed in order to design renovations. The agency planned to convert the monastery into a school, but the drawings for the original building had been destroyed during World War I.



Because of the fanciful old architecture of the Bad Muenster monastery in Germany, creating a CAD model from survey data would been especially challenging. Instead, an architect used software that created CAD models from photographs of the building.

It's a Snap

"Using normal surveying methods, this would have been an enormous project. The building has a complicated and intricate facade with many different wings that have been added. Further complicating the project was the fact that the building was nearly completely hidden by trees on all sides, which would have increased the difficulty of performing a proper survey," explains Hess.

With PhotoModeler, the architect produced 2D and 3D CAD models of the enormous building at a fraction of the time and cost required by more conventional methods.

"Using the modeling software, I estimated that it would take one day to completely photograph the building and another two days to convert the photos into a 3D model," says Hess. He then submitted his bid, leaving plenty of time in which to complete the project.

To create the CAD model, Hess first snapped about 80 photographs of the 3300-square-meter (or about an 11,000-square-foot) building from as many angles as possible using an Olympus C-1400L digital camera, then scanned the images and saved them as standard Kodak PhotoCD format files on an NT-based PC. He also hired a surveyor to measure the distances between the four corners of the building with a theodolite, an instrument with a telescopic sight for establishing horizontal and vertical angles, which later served as reference for scaling the 3D model.

The architect "read" the overlapping photographs of the building into PhotoModeler, where he marked about 250 discrete features (such as the corners of the building, doors, and windows) that appeared on multiple photographs. The software then automatically calculated the position of the camera for each photo (based on a pre-calibrated setting for the specific camera used) and the intersection of light rays from each of the photo positions to create a

3D model of the front, side, and rear walls. According to Hess, that portion of the project took about 16 hours, enabling him to achieve a 3D model in about two days.

Once the model was created, Hess checked its precision, or how closely the software matched the target points in the other photos, which is sometimes adversely affected by low-resolution pictures from some digital cameras. To manipulate the contrast in the photographs for better image quality, Hess used Jasc Software's (Eden Prairie, MN) Paint Shop Pro.

Now that he plans to use PhotoModeler for more projects in the future, especially given the successful outcome of the Bad Muenster model, Hess says he will upgrade his camera for even better image resolution. However, until the quality of digital pictures is resolved, inadequate resolution will continue to hinder this technique.

But for this project, "I was able to significantly improve the precision by deleting and relocating 3D points," he says. Once the margin of error fell to 2 cm, he added additional 3D points to increase detail while resolving the model and verifying known measurements on the photographs.

Using Paint Shop Pro, Hess pulled off textures from the photos and placed them on the model. "Using the actual building textures in the model is very useful in architecture, especially in urban reconstruction projects, where it is important to view the antiquated look of the building. Typical 3D models only show a volumetric view."

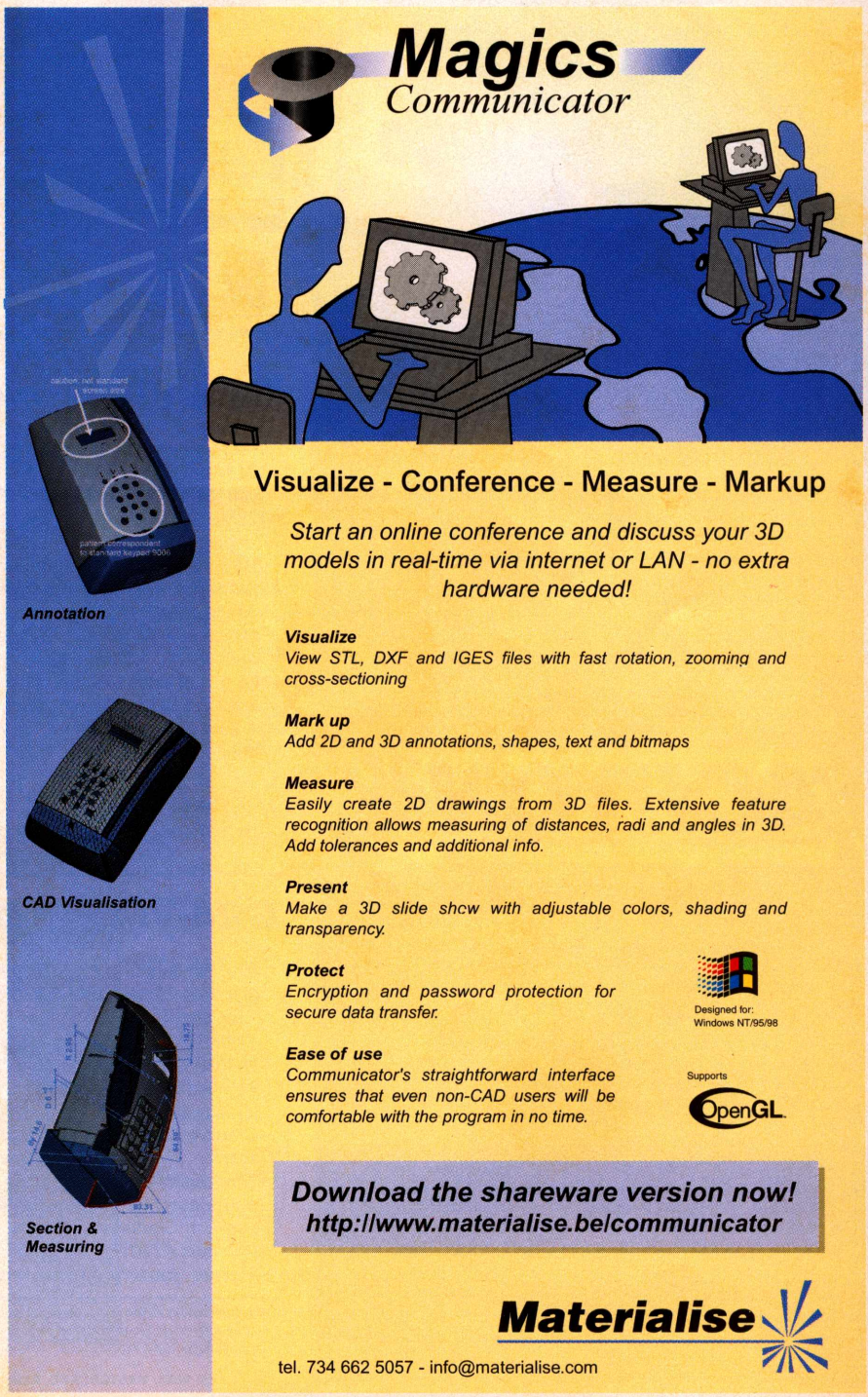
The textured surfaces also played a vital role in the conversion of the imagery. "I chose surfaces from the photographs and directed the software package to update the model so I could see how the model looked in order to validate my choices," Hess explains. From that point, the software tracked the bit map selected for each surface and displayed it in the proper position, regardless of the perspective from which the model was viewed.

After the image was complete, Hess used Point Line's (Baden-Dattwil, Switzerland) 2D CAD software to further develop the drawings. Afterward, he saved the project as a DXF file, exported it into Autodesk's (San Rafael, CA) AutoCAD, then added final touches, such as annotations, dimensions, and comments.

"After the client examined the model, he was amazed at the accuracy and level of detail that I was able to provide for a fraction of the price they had expected to pay. The person even confessed that he had expected I would not be able to deliver for the price I had quoted," Hess says.

According to Hess, creating 3D computer models of structures from photographs can save considerable time in documenting older structures for conservation and renovation, eliminating the costs associated with traditional surveying and photogrammetric methods, which use aerial pictures to achieve accurate survey measurements but not CAD imagery. Says Hess, "PhotoModeler is a very simple way to create computerized design data."

Key Tool **PhotoModeler**, Eos Systems (www.eossystems.com) **infoNOW 62**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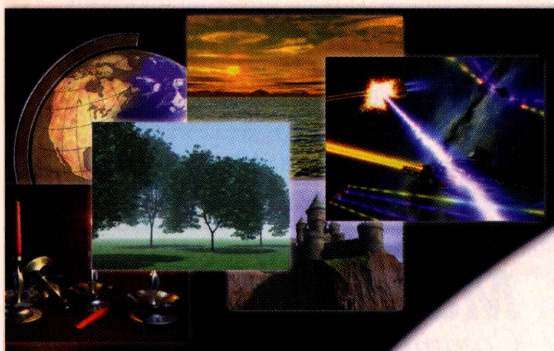

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SolidWorks 99

Staying at the head of the class

BY JEFFREY ROWE

Ever since it first appeared on the CAD scene three years ago, SolidWorks Corp.'s SolidWorks software has offered engineers an easy way to migrate from the 2D to the 3D CAD world. The company continues this tradition with its newest release, SolidWorks 99. Although available at a mid-range price of $3995, the Windows-native program boasts new features, capabilities, and enhancements that are more commonly associated with higher-end packages.

When you sketch and model in 3D, you build relationships, not just geometric forms. SolidWorks 99's 3D Sketcher offers myriad capabilities for creating pipes, tubes, and wires, as well as freeform shapes, such as lofts and sweeps. With this tool, you can now dynamically edit features and sketches, and all affected shapes automatically update, so you don't have to roll back in the design history tree to implement changes.

For drafting and detailing, you can create associative drawings from 3D models, including views, dimensions, and rotations. When you change a drawing, the model, view, and assembly automatically update.

With the software's new Surface Healing translation tool, you can automatically run diagnoses on imported files. It works much like a spell checker for imported surfaces: Problems are identified both graphically and with text, and you can remove or replace badly gapped surfaces automatically or manually. However, surfacing in general remains a weakness in Solidworks. It still has no surface-trim or extend capabilities (though SolidWorks claims it is working to overcome these shortcomings in future releases).

Like some of its competitors (notably, think3 with its thinkdesign package), SolidWorks is also trying to woo 2D AutoCAD users to 3D. Along those lines, the company has implemented into SolidWorks 99 an AutoCAD command line emulator, which recognizes 40 frequently used AutoCAD commands within SolidWorks.

Assembly line

The ability to manage the assembly process from within an assembly itself, and the way you can reference geometry surrounding an assembly without having to export parameters or write equations are just two of the features that set SolidWorks apart from much of the competition. Also, relationships between parts in assemblies update automatically as you make changes.

Although not a brand-new offering (it was introduced in SolidWorks 98Plus), the snap-to-fit SmartMates feature automatically captures assembly-mating relationships. All you need to do is drag a component part into an assembly view, and the part automatically snaps into position relative to the rest of the assembly.

SolidWorks 99 also features real-time collision detection, with which you can find and fix design problems in assemblies that contain moving parts. You simply click on a component and drag it, and the entire assembly moves. If any of the parts collide, the software will notify you by sound, or by "freezing" the assembly's movement.

As comprehensive as SolidWorks 99 is, a couple of additional tools really help round out its utility for many users. For instance, the software's new sheet-metal design capabilities enable you to easily create sheet-metal parts in 3D or 2D. Furthermore, you can automatically calculate bend radii, flatten 3D designs for production, and automatically dimension drawings.

Two additional features, SolidWorks Piping and FeatureWorks, are sold as separate modules. SolidWorks Piping is a 3D solid piping design package and fittings library that contains more than 1700 drag-and-drop parts. You can also create and save your own.

FeatureWorks is a feature-recognition package that works in conjunction with SolidWorks to recognize parametric features from files produced by standard 3D translators. FeatureWorks applies "intelligence" to static geometric data, making it ready to use in SolidWorks 99. Using FeatureWorks, you can share 3D models with different CAD systems as well as exploit legacy data.

All told, SolidWorks 99 is a powerful enhancement to SolidWorks' award-winning 3D mechanical design package. The package remains at the front of the class when it comes to desktop 3D modeling products.

The SmartMates feature in SolidWorks 99 automatically captures assembly-mating relationships.

SolidWorks 99

PRICE: SolidWorks 99, $3995; SolidWorks Piping, $995; FeatureWorks, $495

MINIMUM SYSTEM REQUIREMENTS: Windows 95/98/NT; Pentium or better processor; 64MB of RAM; approximately 90MB of hard-disk space

SolidWorks Corp.

Concord, MA
978-371-5000
www.solidworks.com
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Jeffrey Rowe is the principal of Cairowest Group, llc, an independent design consulting firm. He can be reached at 719-539-8549 or at jrowe@cairowest.com.

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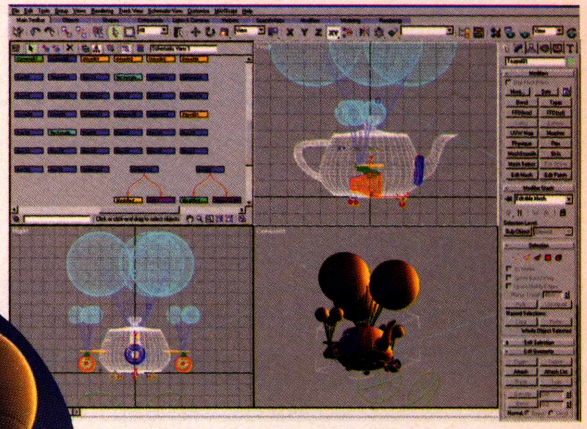
PennWell

3D Studio Max R3

A powerful revision to a popular modeling and animation package

BY GEORGE MAESTRI



Max's customizable interface includes a schematic window (upper left) that displays a block diagram of your scene.

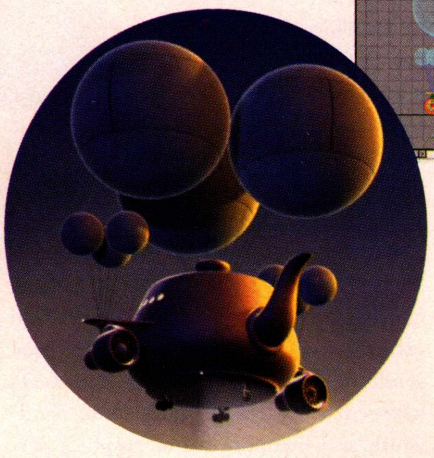
With Version 3.0 of its 3D Studio Max modeling and animation software, Discreet has made a great product even better. The program now boasts a host of innovative features, including a customizable interface, redesigned renderer, object referencing, and powerful animation and organic modeling capabilities.

The new interface in Max R3 has customizable tabs that enable users to create toolbars reflecting the needs of their current project. Selected objects now sport XYZ arrows, which can be used to translate the objects along any specific axis, affording a much better degree of control during both modeling and animation.

Those who work in large groups will find the object-referencing tool in R3 indispensable. If a user remodels or changes the color of a character, the change will propagate through the system and be reflected in all the shots that contain that character.

The modeler in R3 has also undergone a few revisions. In addition to updating the modeling interface to simplify the task of switching between sub-object levels, Discreet has also rounded out the feature set in the system's polygonal modeler to include face beveling and edge chamfering tools.

One of the most exciting new features in R3 is the renderer, which has undergone a sorely needed overhaul. Anti-aliasing is now managed via plug-ins, which enables users to achieve many different "looks" in their scenes. For instance, the Oren-Nayar Blinn shader creates beautifully soft surfaces. Ray-tracing has also been improved; R3 renders much faster than previous versions.



The renderer in Max R3 has features that significantly improve image quality.

Most rendering effects in Max R3 are now part of the renderer rather than the video post-production process, making it much easier to set up and render a shot with many effects. These include glows, film grain, and depth of field, and are basically the same as those in previous versions of the software. The depth-of-field module still needs some work, as it is simply a Z-buffer-based blurring effect that does not take hidden pixels into account and can cause unwanted artifacts at the edges of objects.

For character animators, Max R3 has a number of new features. Skin is a mesh deformation tool that enables users to create envelopes of variable strength and assign vertices to specific bones. Morpher, a multiple-target facial-animation morph utility, enables users to create very complex shape animation.

Character animators should also like the new version of MeshSmooth, which lets users subdivide simple polygonal models into smooth surfaces. Meshsmooth also has a feature dubbed NURMS, which enables users to weight individual vertices or edges of the polygonal mesh and provides NURBS-like control over the smoothed surface. It is so easy to create and animate characters with MeshSMooth that I don't think I'll ever go back to NURBS again.

For an added dose of realism, Discreet has included Flex, a soft body-dynamics system. Flex enables the shape of an object to automatically stretch as it moves, which is great for non-rigid operations, such as making the fat belly of a character jiggle automatically. One feature missing from this system is collision detection, which would enable a soft object to react to the surface of other objects.

Finally, Max R3 offers a new class of motion controllers called Reactors, which enable users to create relationships between objects. Using a Reactor in Max R3, users can, for example, link the rotation of tires to the motion of a car. Although these Reactors work, I found the interface somewhat arcane. Instead of a visual reference, such as an animation curve, the interface uses numerical values, making it much harder to visualize an object's motion.

Despite these minor grievances, Release 3 of 3D Studio Max is truly a wonderful product. At a price of only $3495, the software provides excellent bang for the buck. The new interface and renderer, as well as the many other improvements and tools in this release, make 3D Studio Max R3 a robust animation system.

3D Studio Max Release 3

PRICE: $3495

MINIMUM SYSTEM REQUIREMENTS: Windows 98/NT 4.0; 150MHz or better Intel-compatible processor; 64MB of RAM

Discreet, a Division of Autodesk
San Francisco, CA
800-225-7904
www.ktx.com
infoNOW 57

George Maestri is a writer and animator living in Los Angeles.

Intergraph TDZ 2000 GL2

Premium performance, premium price

BY GEORGE MAESTRI

Intergraph's latest NT offering comes in a wide variety of configurations.

Intergraph has always been a leader in developing Windows NT graphics workstations. The company was one of the first to offer high-end graphics and 3D solutions for this market at a time when most people were still using Unix-based systems. Its Wildcat graphics adapters have been at the front of the pack in terms of NT graphics performance since that technology's introduction several years ago, and the new TDZ 2000 GL2 workstation maintains that trend with a blazingly fast OpenGL accelerator. However, this performance comes at a premium price of $8900.

The TDZ 2000 is housed in what has now become Intergraph's standard mid-size tower enclosure. The case is an attractive bluish-purple, with a sliding hatch that reveals the CD-ROM player and the floppy drives. The case also features two additional 5-inch external bays, as well as three 3-inch bays, one of which is taken by the system drive. This housing provides easy access to the innards of the computer through two sliding hatches. The top of the case pops off, then the left side of the box slides upward.

In an attempt to make the system affordable, Intergraph used the less-expensive Pentium II and III chips, as well as a number of off-the-shelf components, including a Tyan OEM motherboard. The Tyan allows for one AGP, five PCI, and two ISA slots. Above these slots live the dual Pentium III CPUs, which are encased in heavy-duty heatsinks. The hard disk in the base model is EIDE based. For those who need more performance, a SCSI disk can be configured as well, which requires the installation of a SCSI adapter in one of the PCI slots.

Graphics for the system can be supplied by any number of optional cards, from a basic Matrox Millennium board up to Intergraph's brand-new Intense 3D Wildcat 4105. The system I reviewed came with the Wildcat 4100, the previous version of that card.

The Wildcat graphics adapter actually consists of two cards, an AGP-based geometry accelerator and a PCI-based rendering engine. Splitting the tasks between two cards provides more bandwidth and therefore better graphics performance. The 4100 is very fast, certainly one of the faster cards on the market. Texture memory is a healthy 64MB, which should satisfy the appetites of most graphics applications.

The network card is a standard 3Com 100 fast-ethernet adapter, which occupies one of the PCI slots. The system did not have ethernet on the motherboard, as do many of the other systems in this price range. While this scenario gives you the option to select other types of network cards, such as Token Ring, the vast majority of people use ethernet, and this configuration does take up a valuable PCI slot.

The audio card is a standard SoundBlaster. As with the network card, sound might also have been provided on the motherboard, which would have saved a valuable slot. One little glitch was that the audio cable from the SoundBlaster to the CD-ROM drive was a half-inch too short, causing the cable to pull on the card. This setup could conceivably lead to damage of the card, the cable, or both. The problem could have been easily avoided if the SoundBlaster were installed in the first ISA slot, rather than the last one at the bottom of the computer.

Intergraph TDZ 2000 GL2

BASE PRICE: $2,049
PRICE AS REVIEWED: $8,929
CONFIGURATION AS REVIEWED: Dual Pentium III 550MHz processors; 256MB of RAM, 9GB SCSI hard disk, Wildcat 4100 OpenGL accelerator

Intergraph Corp.
Huntsville, AL
800-345-4856
www.intergraph.com
infoNOW 58

As for system speed, as would be expected with the Wildcat card, performance was excellent. I discovered this after I ran Softimage, Maya, and 3D Studio Max on the machine. All these demanding packages worked well, and I couldn't find any specific problems with the OpenGL drivers. Intergraph has done a good job of working with these application vendors to provide excellent support.

Prices for this machine vary widely, depending on the system and the configuration. The base system with a 400MHz Pentium II, 64MB of RAM, 10GB EIDE drive, and Matrox Millennium card goes for $2049. This is expensive compared with similarly configured systems from other vendors.

The Wildcat graphics adapter provides excellent performance, and for some users, this may be reason enough to purchase the TDZ 2000 GL. Intergraph also provides excellent service from a network of on-site technicians. Still, for this price, I would expect a little more from the system, such as a pair of Xeon processors and tighter integration of components such as audio and ethernet.

Overall, the TDZ 2000 GL2 is a solid workhorse. If you need optimum graphics performance, it may be a good option. Those watching their pennies and able to work with a more modest machine, however, may want to look elsewhere.

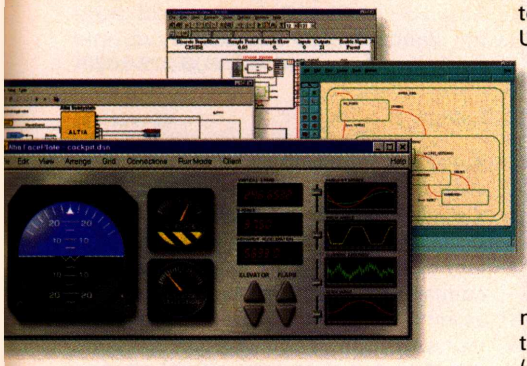
George Maestri is a writer and animator living in Los Angeles.

PRODUCTS

SOFTWARE

DESIGN ENGINEERING

SAVING FACE
WIN/UNIX From Altia Inc., Altia FacePlate 4.0 simulation graphics software and component libraries help embedded systems engineers create



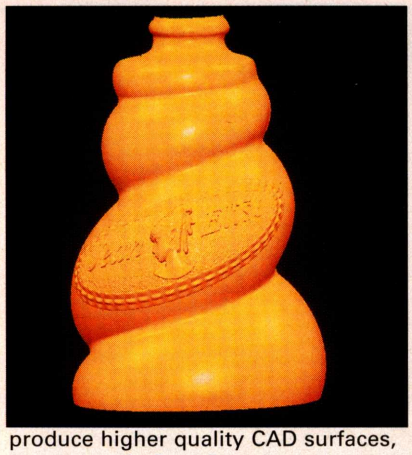
interactive user interfaces and animated graphics without programming or graphic design expertise. Users begin by assembling drag-and-drop graphics components from libraries. A finished design can then be connected to all major system simulation software programs by clicking on signal names in the Connection Dialogue. The front panel not only exhibits the final product's proposed behavior but also provides a good working representation of how it will look as a finished product. The price is $995. (Colorado Springs, CO; 719-598-4299; www.altia.com)
infoNOW 75

DIGITIZING INTERFACE
WIN Inscribe 3.0 from Immersion Corporation enables 3D artists and engineers to digitize points, curves, and surfaces directly in most Windows 98/NT 3D graphics and CAD packages. The new auto-plot function enables users to trace an object contour and create evenly spaced points. Mapping enables users to digitize a very large

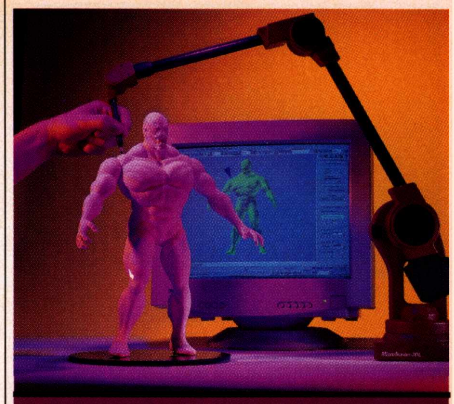
object in several sections. With scan planes, users can create 2D cross-section slices of a 3D physical object. The software is used with the company's MicroScribe 3D digitizing system. The price is less than $3000. (San Jose, CA; 408-467-1900; www.immerse.com)
infoNOW 76

DESIGN SIMULATION
WIN DesignSpace v5 from Ansys provides easy setup of an assembly analysis using new automatic contact surface detection and automatic surface-to-surface contact element creation. Users can specify one part in the assembly to be non-critical while dialing in the adjacent part to be critical for higher accuracy. This ability to automatically generate completely dissimilar mesh densities on adjacent parts allows for efficient assembly analysis, resulting in more design iterations in less time. Also included is DesignSpace Report II, an automatic report generator that now supports the assembly capabilities. The price is not available. (Canonsburg, PA; 724-514-3188; www.ansys.com)
infoNOW 77

REVERSE ENGINEERING
WIN Key new features of Delcam International's CopyCAD 2.1 software for reverse engineering enable users to



produce higher quality CAD surfaces, faster than before, from both scanned and digitized data. An automatic filtering algorithm eliminates rogue points that tend to generate wrinkles in surfaces. New data translation capabilities ensure high-quality results regardless of the source of the original data. Techniques that verify the quality of the surfaces include surface smoothness shading to check for discontinuities; tools to verify the accuracy of points in relation to other points and to surfaces; and multiple scan alignment to eliminate tolerance stackups. The price starts at $12,000. (Windsor, Ontario; 519-974-8088; www.delcam.com)
infoNOW 78



For more info visit:
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WIN Fully equipped with world-class data translators and intuitive 3D geometric construction and editing functionality, Cadkey Wireframe from Baystate Technologies enables users to design, visualize, and validate product concepts through rapid prototyping. The product offers comprehensive, automated 2D drafting and detailing based on ANSI, ISO, DIN, and JIS drafting standards. The introductory price is $495. (Marlborough, MA; 508-229-2020; www.cadkey.com)
infoNOW 79

ANIMATE ASSEMBLIES
WIN Available from SolidWorks for SolidWorks 99, the SolidWorks Animator animation and visualization tool enables users to capture and create animations for existing parts and assemblies. The animations can then be replayed within SolidWorks or in the AVI format. A default assistant called the Animation Wizard enables users to create animations with a click of the mouse. When the user dynamically manipulates an assembly, the software automatically captures the motion. A screen-capture function enables users to automatically capture all graphic information in SolidWorks 99. The price is $495. (Concord, MA; 978-371-5000; www.solidworks.com)
infoNOW 80

LIBRARIES

MEGA MODELS
WIN Animals, humans, airplanes, and other vehicles are among the 5000 3D models offered in the nine-CD collection, De Espona 3D Enciclopedia, from De Espona Infografica, SL. The models consist of 8500 textures and more than 250 million polygons, and are available in 3D Studio Max format. The collection costs $495. (Ballesta, Madrid, Spain; +34 91 521 27 22; www.deespona.com)
infoNOW 81

STOCK FOOTAGE
WIN/MAC/UNIX The 32-title collection called The Professional Series from Dynamic Graphics provides royalty-free digital-video stock footage. The images in this series were originally captured on film or Beta SP and have been digitally remastered for high picture quality. The collection conforms to NTSC and PAL broadcast standards and full-screen-flattened QuickTime movies in high-resolution, 24-bit color using photo JPEG compression. Individual CD-ROM titles cost $399. (Peoria, IL; 309-688-8800; www.dgusa.com)
infoNOW 82

MEDIEVAL ART
WIN New from Art Recon, Recon3D Vol.2 is a collection of historical objects dedicated to Romanesque and Gothic art. The collection brings to life more than 350 elements characteristic of the Middle Ages that have been reconstructed from historical data. Mid- to high-resolution polygonal models ensure a high-quality appearance in five industry-standard formats. The price is $249. (Calgary, Alberta; 403-289-2454; www.artrecon.com)
infoNOW 83

MISCELLANEOUS

MULTI-SENSORY SOFTWARE
WIN/UNIX Most notable among the enhancements to MUSE Technologies' MuSE (Multi-dimensional user-oriented Synthetic Environment) Development System Version 1.6.4 is the integration of the company's human-computer interface and network collaboration products. The product supports multi-pipe, multi-screen NxM screen arrays and picture-generation capabilities as well as the ability to render large, complex OpenInventor models. A high-resolution quad-buffered stereoscopic 3D display is available with stereo in a window effect. The entry-level price is $15,000 for Windows NT and $22,500 for Unix. (Albuquerque, NM; 800-711-3899; www.musetech.com)
infoNOW 84

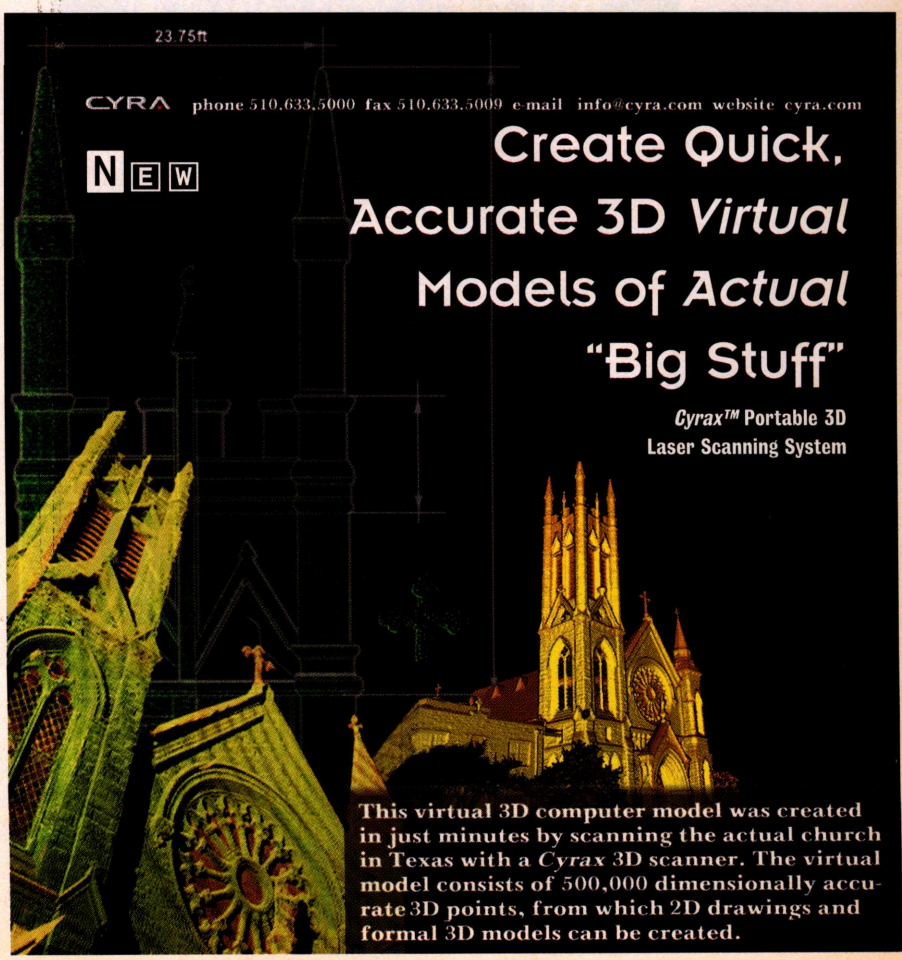
SPANNING DISPLAYS
WIN A software-only toolkit, MultiVis from CG2 enables graphics applications to seamlessly span an unlimited number of computer displays. The user is not limited to specific hardware vendors, and all graphics hardware does not have to be the same. The software is configurable with any display technology, including projection systems, head-mounted displays, and monitors. The user can integrate MultiVis into any 3D application with little coding. Once an application is MultiVis ready, the end user assigns and configures each display's orientation and position at run time using the MultiVis GUI. Each view can be adjusted on the fly. The price is not available. (Huntsville, AL; 256-533-2703; www.cg2.com)
infoNOW 85

TRICKS WITH TEXT
WIN Utilizing the TrueType fonts and symbols available on a PC, Font FX 2.5 from Electric Rain produces 3D text images and 3D text animations appropriate for Web and graphic designers, desktop publishers, production and digital imaging artists, and multimedia developers. Users can control colors, viewing angles, lighting effects, textures, and backgrounds while using Visual Crystal Trackballs for on-screen manipulation and positioning of text. Users can export all 3D graphic files in an array of bitmap formats, along with GIF and JPG formats for Web page design. In addition, users can import EPS files and tweak them into 3D objects. The price is $39.95 downloaded from the company's Web site. (Boulder, CO; 303-543-8233; www.erain.com)
infoNOW 86

MODELING AND ANIMATION

MOTION CAPTURE LIBRARY
WIN Muybridge Variations from Digimation offers more than 500 motion capture moves for 3D Studio Max and Character Studio 2. The biped format is at the NTSC rate of 30 frames per second and integrates with existing Max scenes and characters. The product contains more than 40 separate categories of movement, which can be layered with the user's animation. The animator can create dance, sport, walk cycles, character runs, and ambient movement. Users can integrate props as well as supporting characters into groups and crowds. The price is $395. (St. Rose, LA; 504-468-7898; www.digimation.com)
infoNOW 87

ULTIMATE PAINTING
WIN/MAC Painter 6 from MetaCreations includes the ability to paint in depth with brushes, run text along a curve, and layer vector and bitmap images in one file for output to print and the Web. Functionality enhancements include an updated, more intuitive interface, significant speed improvements, industry-standard layers implementation, and CMYK TIFF support. The software offers support for the Wacom Intuos tablet, pen, and airbrush technology. The price is $399. Upgrades from previous releases are $149. (Santa Barbara County, CA; 800-846-0111;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www.metacreations.com/products/painter6)
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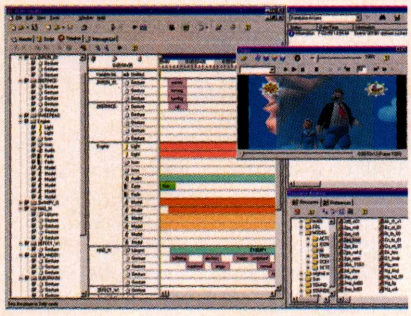
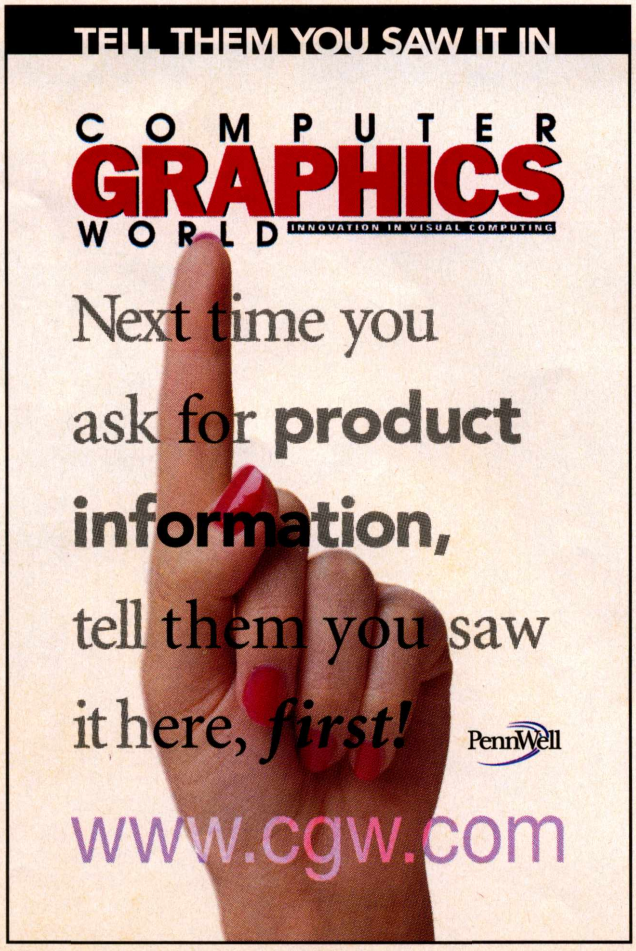
BRILLIANT ANIMATION
WIN/MAC For creating interactive 3D content for distribution on the Internet, DVD, CD-ROM, and broadcast video, Brilliant Digital offers B3D



Studio. Content can be created once, then output at a different compression level, polygon count, and sound quality. Features include a highly responsive integrated multi-user development environment, nonlinear editing of realtime 3D clips, a dynamic library model replacement system, and an advanced exporter for 3D Studio Max R2 and R3. The price is $495. (Los Angeles, CA; 310-450-1482; www.bde3d.com)
infoNOW 89

KEEPING STEP
WIN/UNIX From Digital Processing Systems comes DPS Lockstep 3.0 for 3D Studio Max R3. Users can control their Perception (PVR), Perception RT, Hollywood, and Personal Animation Recorder (PAR NT) DDRs from within the 3D Studio Max R3 environment. The plug-in features a frame buffer device rendering mode that enables unlimited test renders without users having to delete files. It provides support for rotoscoping and video clips in the viewport. Video, animations, and stills on the DDR drive show up within the Max dialog boxes. The product is available as a free download to all registered DPS PVR, PAR NT, Hollywood, and Perception RT/RT3DX owners. (Markham, Ontario; 800-775-3314; www.dps.com)
infoNOW 90



EVENTS

October

13-14 · Medical Design and Manufacturing (MD&M), held in Minneapolis, MN. Contact: Canon Communications LLC (310-445-4200); (fax: 310-996-9499); www.mdm-minneapolis.com

13-16 · Association for Graphic Arts Training Annual Conference, held in Schamburg, IL. Contact: Assocation for Graphic Arts Training (800-214-1120); www.napl.org/agat

17-20 · Graph Expo '99/Converting Expo '99, held in Chicago. Contact: Graphic Arts Show (703-264-7200); www.gasc.org

17-22 · NIP15: International Conference on Digital Printing Technologies, held in Orlando, FL. Contact: IS&T (703-642-9090); (fax: 703-642-9094); www.imaging.org

19-22 · Digital Video Conference & Exposition, held in Long Beach, CA. Contact: Miller Freeman Inc. (415-278-5300); (fax: 415-278-5200); www.dvexpo.com

19-23 · Broadcast India '99, held in Mumbai, India. Contact: Saicom Trade Fairs & Exhibitions Pvt. Ltd. (91-22-215-1396); (fax: 91-22-215-1269); www.saicm.com/broadcastindia

November

15-19 · Comdex/Fall '99, held in Las Vegas. Contact: ZD Events (781-433-1805); www.comdex.com

16-18 · Digital Media World, held in London, UK. Contact: Advanstar Communication (+44-1244-399-180); (fax: +44-171-559-9779); www.digmedia.com

16-20 · The International Association of Amusement Parks and Attractions (IAAPA), held in Atlanta, GA. Contact: IAAPA (703-836-4800); (fax: 703-836-2824); www.iaapa.org

December

1-4 · EuroMold '99, held in Frankfurt, Germany. Contact: DEMAT Expo Management (tel: +49-69-23-43-31): (fax: +49-69-25-30-71); www.euromold.com

12-13 · Game Developers RoadTrips Conference, held in Boston. Contact: GDC RoadTrips (415-905-2388); (fax: 415-905-2222); www.gdconf.com/rtdm

January

4-8 · MacWorld Expo, held in San Francisco. Contact: IDG Expo (781-551-9800); (fax: 781-440-0300); www.macworldexpo.com

27-30 · Medicine Meets Virtual Reality, held in Newport Beach, CA. Contact: Aligned Management Associates Inc. (860-444-0362); (fax: 860-447-9767); www.amainc.com/MMVR/MMVR.html

31-Feb 2 · Imagina, held in Monaco. Contact: Imagina (tel: +377-93-15-93-94); (fax: +377-93-15-93-95); www.ina.fr/Imagina/99/Evenements/concours.en.html

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Company name:_____

Mailing address:_____

Phone numbers (toll-free, if applicable, and toll): _____

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Product name, including version number:_____

Brief description of product and its target user: _____

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Price: _____

How the product demonstrates innovation and how that innovation is unique (indicate what technological barrier the product breaks, what problem it solves, and how that benefits the user):_____

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Contact name at company in case of questions: _____

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Please fill out and fax this nomination form (one per product) to the attention of Michelle Lendway at 603-891-0539 by October 15, 1999.

Forms are also available on our Web site at **www.cgw.com**.

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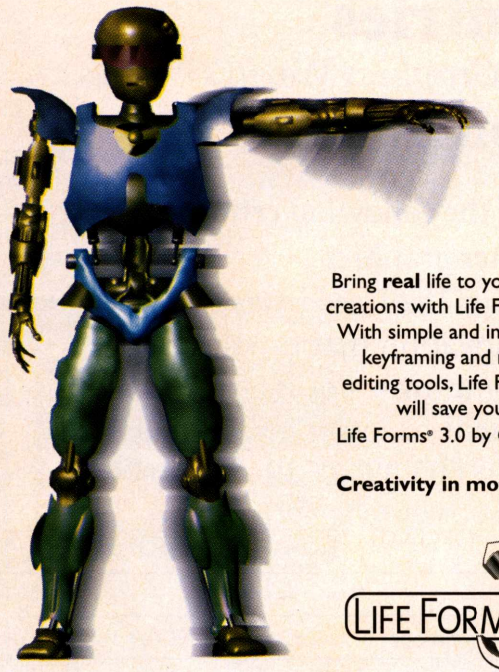

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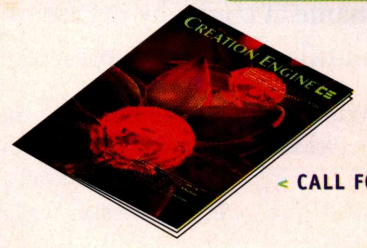

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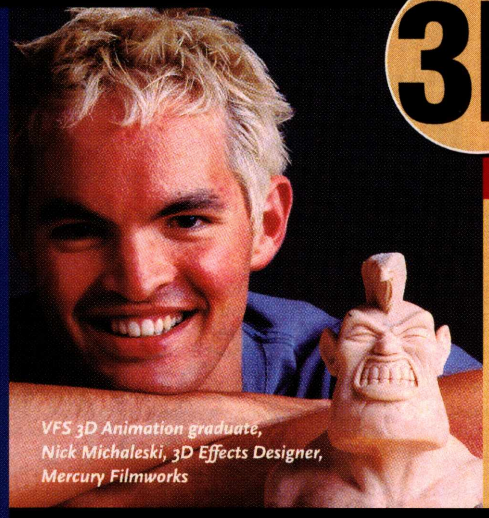

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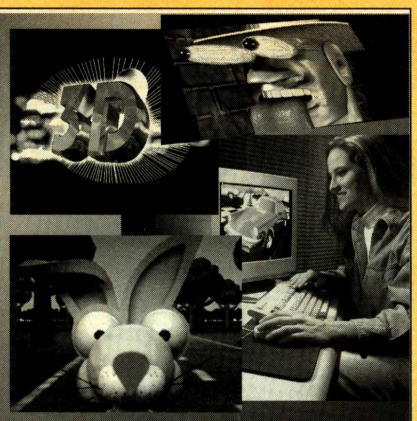

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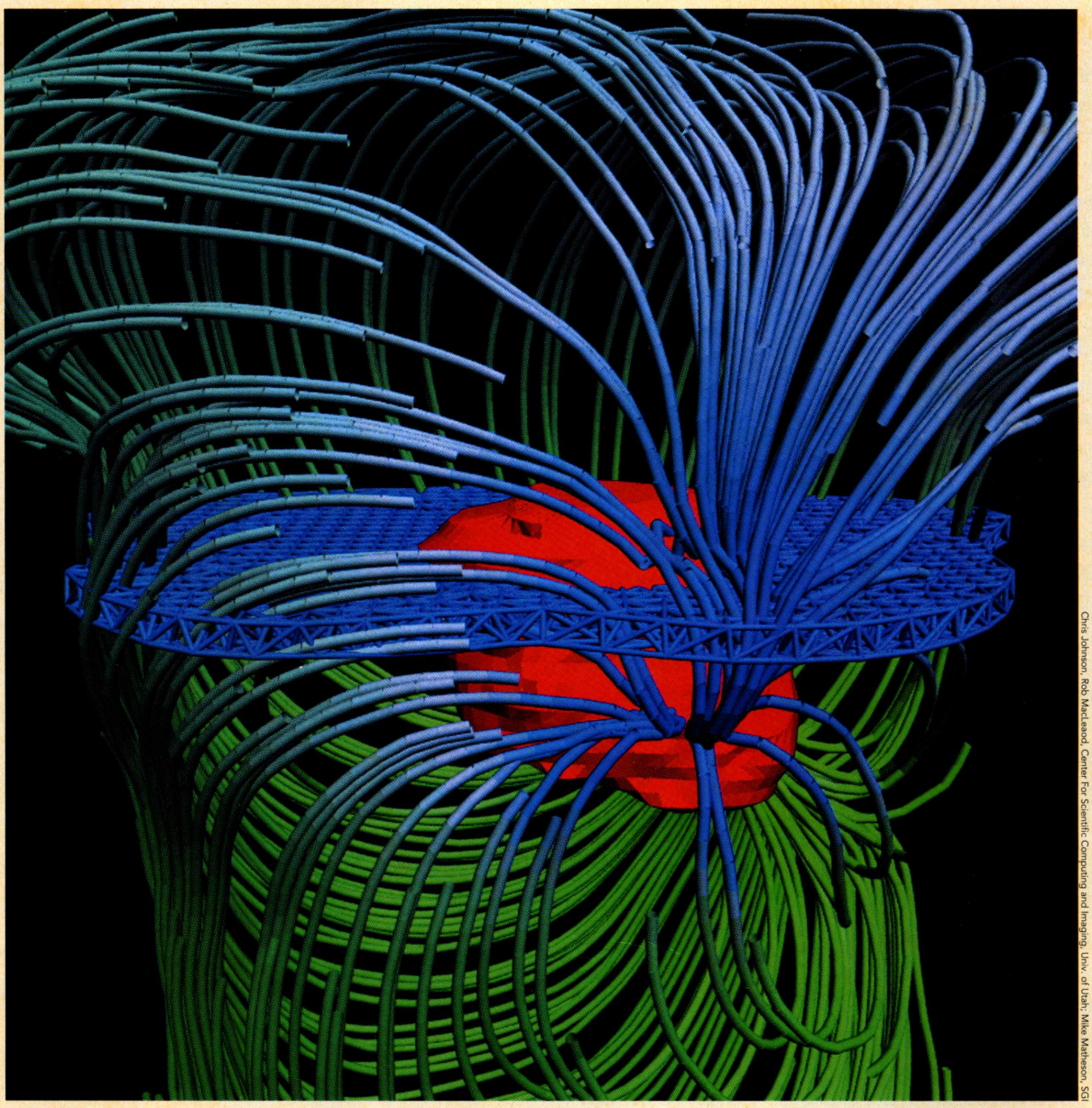

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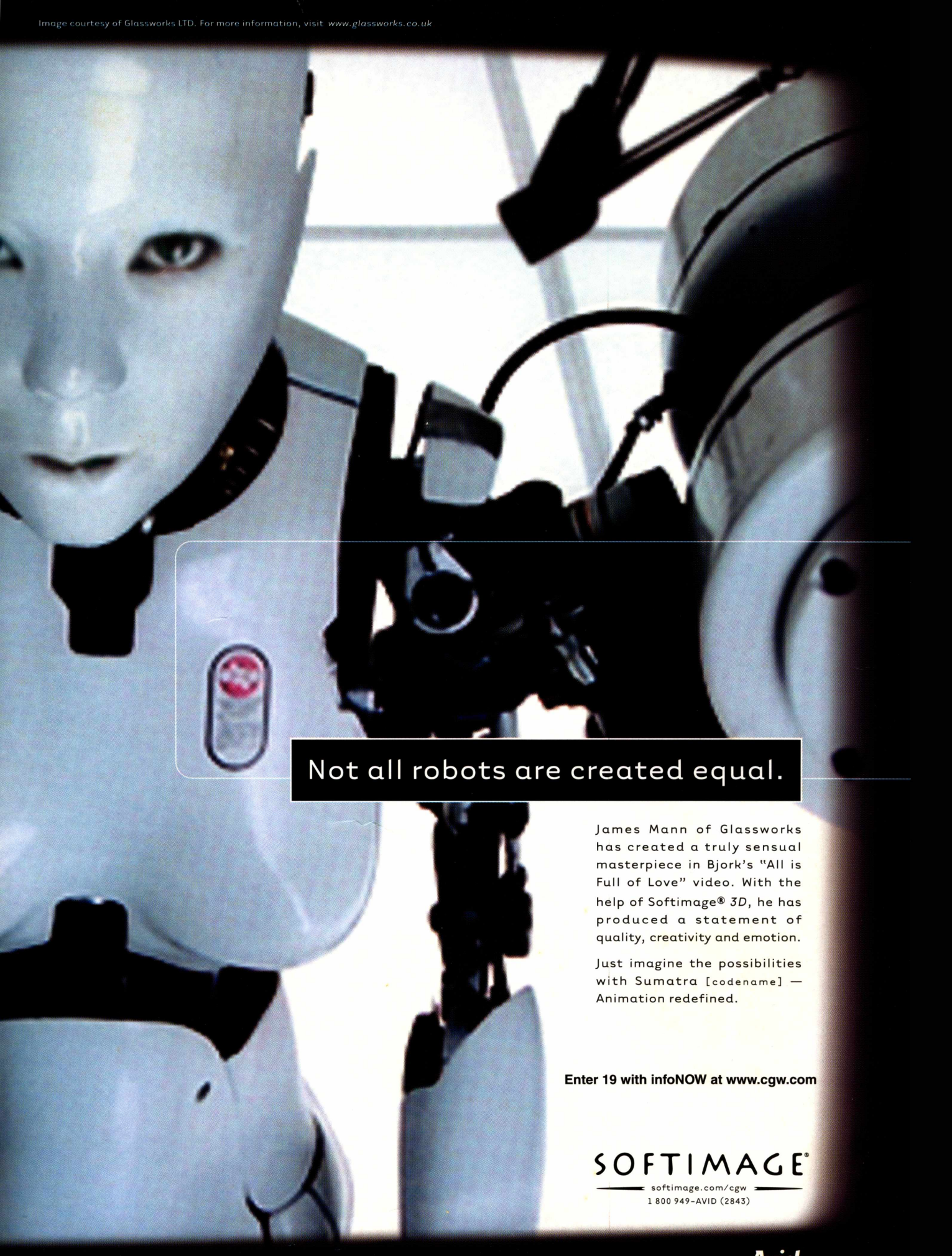

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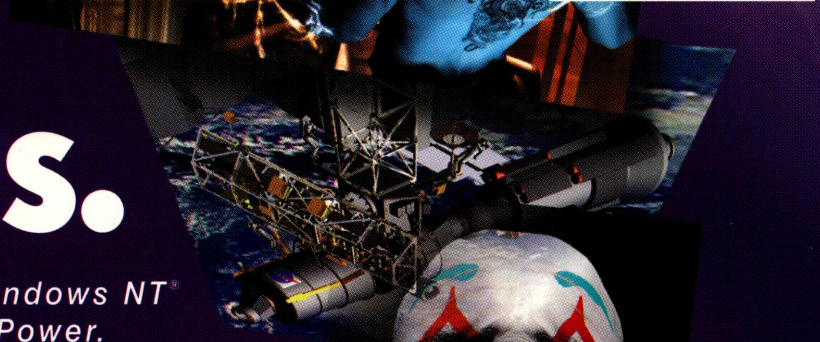

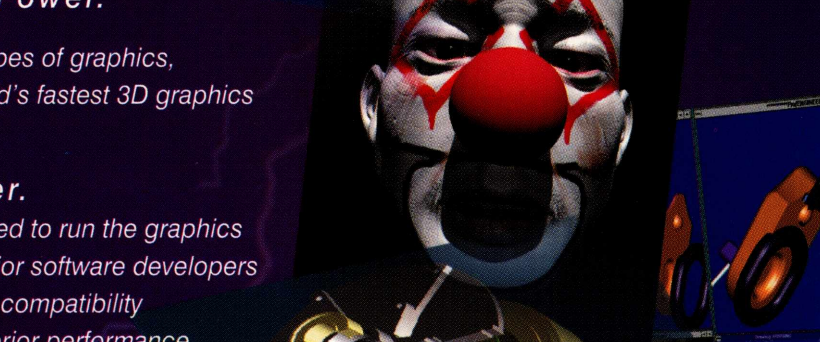

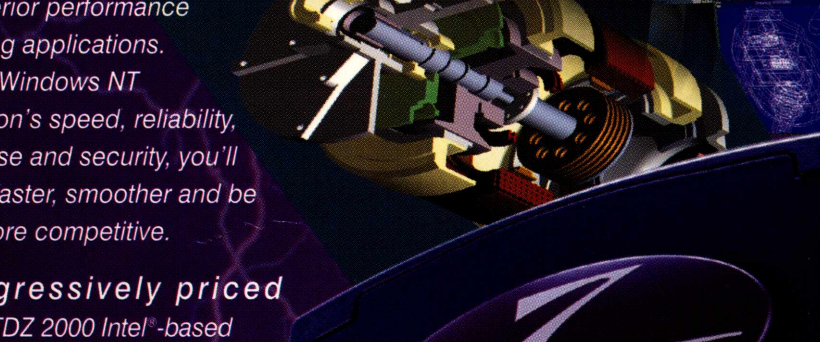

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